



The Blast Furnace and Steel Plant

Published the first of each month by the National Iron and Steel Publishing Co.

Main Office — Thaw Building, 108 Smithfield Street, Pittsburgh.

DISTRICT OFFICES—NEW YORK AND CHICAGO.

President: H. A. Andresen. Vice President and Treasurer: F. C. Andresen. Secretary: M. M. Zeder.
Engineering Editor: ALFRED M. STAHLER. Associate Editor: A. W. PETERSON.

EDITORIAL ADVISORY BOARD:

William A. Field W. Trinks Fred Crabtree Kenneth B. Lewis
Barton R. Shover Dr. George B. Waterhouse E. H. McClelland A. G. Smith

Subscription Price:—In the United States, \$1 per year; Canada, \$1.50; all other countries, \$2. Single Copy, 15 Cents.
Entered as second-class mail matter at Pittsburgh, Pa., under the Act of Congress, March 3, 1879.

Index to Contents

VOL. VII.		JUNE, 1919.		No. 6	
	Page		Page		Page
PROSPERITY IN STEEL INDUSTRY PREDICTED	251	METALLURGICAL CONSIDERATIONS OF DUPLEXING—PART II	287		
BY ELBERT H. GARY.		BY RICHARD S. McCAFFERY.			
OPTIMISM KEYNOTE OF INSTITUTE MEETING	253	MODERN FORGE PLANT FOR ORDNANCE WORK	289		
MAMMOTH COKE PLANT	256	BY C. J. WALKER.			
BY FRANK F. MARQUARD.		CONTINUOUS PAIR OR BAR HEATING FURNACE	292		
ELECTRIC SOAKING PITS AND FUR- NACES	264	CONTINUOUS ANNEALING AND BLUING FURNACE	293		
BY T. F. BAILEY.		HEATING FURNACES AND ANNEALING FURNACES—PART VI	294		
GOVERNMENT STEEL PLANT	268	BY W. TRINKS.			
BY S. W. STRATTON.		METHODS OF BLAST FURNACE CHARG- ING	298		
ANNOUNCEMENT OF STEEL MILL STEAM POWER DEPARTMENT	271	BY A. J. MOHR.			
HOW DO YOU UTILIZE YOUR EXHAUST STEAM?	272	FOREIGN RELATIONS	306		
BY D. O. TYLER.		PRODUCTION TOPICS	308		
COMBUSTION CONTROL IN MILL BOILER PLANT PART I	274	INDUSTRIAL RELATIONS	309		
BY ROBERT JUNE.		NEWS OF THE PLANTS	310		
ECONOMICAL FUEL BURNING EQUIP- MENT	277	OPEN HEARTH	311		
BY J. G. WORKER.		SOME POINTERS ON BY-PRODUCT COKE OVEN OPERATION	313		
UNIQUE PUMP HOUSE FOR BLAST FUR- NACE	281	WITH THE EQUIPMENT MANUFAC- TURERS	314		
SUGGESTIONS FOR CORRECT BOILER RAFFLING	283	TRADE NOTES, TRADE PUBLICATIONS, SOCIETY MEETINGS	316		
BY A. D. WILLIAMS.					

The Blast Furnace *and* Steel Plant

VOL. VII.

PITTSBURGH, PA., JUNE, 1919.

No. 6

Prosperity in Steel Industry Predicted

**Part Performed by Iron and Steel Institute During War
Reviewed—Meeting With Foreign Steel Representatives Hinted.
Confidence in Business Outlook Expressed.**

By ELBERT H. GARY.

A great change has come over the people of all nations since our last annual meeting. The world war seems to have been terminated though the details of the peace terms have not yet been fully agreed upon. We may properly rejoice that negotiations have reached the point where it seems probable peace will be established, although we cannot as yet see clearly into the far future. Glancing back one year we may be thankful. The outlook in France and other parts of Europe was then very dark. We were anxious and distressed, but not without the courage of conviction as to final results. Right has triumphed. An overruling Providence has protected civilization against ruthless attack. All nations and peoples rendering service on the side of justice, faithfully and effectively performed their respective parts.

It is appropriate to refer briefly to the part the members of this institute performed in winning the war; not with a disposition to boast or to claim credit, but rather with a feeling of gratitude that they were permitted to assist in defending a righteous cause.

During the progress of the war we were frequently informed by representatives of the United States government, military and civil, who were in authority and directly connected with the purchase of supplies required for war purposes, that steel was of the highest importance and we were urged to increase capacity and to hasten production; we were requested to devote our time, money and energy in behalf of our government and its associates in the war to the exclusion of everything else. It was emphasized that if disaster was to be averted there must be additional war material, food supplies and transportation facilities and that larger and larger quantities of steel were fundamental to all these means of carrying on the war. Repeatedly statements were made to us that the demands made for steel, both as to quantities and deliveries were impossible of fulfillment.

However, the manufacturers never became disheartened or demoralized. They listened patiently to the claims and reasons presented and then considered carefully all figures bearing upon the subject of necessi-

ties and ability to produce and made their calculations accordingly. Fired with feelings of patriotism, yet with composed minds and determined spirits, those in control of the iron and steel industry again and again promised that steel would be furnished when and as required for military purposes.

It is sufficient to say that in every substantial particular the iron and steel industry made good all promises. There were no deficiencies in quantities nor delays in deliveries which were harmful. If these matters had been left entirely in the hands of the general committee of the American Iron and Steel Institute there would have been no delinquencies whatever.

We now have reason to assume the peace terms will be agreed to and subscribed at least by the majority of governments and that a league of nations for the continued preservation of peace will be established. A large majority of the people of all countries are favorable to these results and their desire and will must prevail. If the plan adopted, in form or substance, shall prove, by experience, to be imperfect or incomplete, corrections or amendments can be made later. If the plan turns out to be unworkable or unsatisfactory it can and will be abandoned. Naturally everyone is wondering whether or not peace will be permanent or long continued. There are numerous things to be considered, too many for discussion or even reference at this time; but the controlling factor in this respect is one of fairness to all nations, taking all the facts and circumstances into account. If, at the start, either the treaty of peace or constitution of the league of nations is manifestly unjust and unfair to any leading country it will turn out to be a temporary arrangement only. Honesty, justice, truth and Christian spirit are all kindred to and have a bearing upon the idea of fairness.

It is to be presumed the central governments with their associates in the war will sign the terms of peace offered, or will at least submit to them. They are helpless and have no alternative. For this reason, if for no other, those who tender the terms of peace should be more considerate and painstaking.

There must be maintained at present composure and judicial temperament having in view the long

Abstract of address made before May, 1919, meeting of the American Iron and Steel Institute.

future and the vital welfare of the whole world. As we hate wrong, it is natural to hate those who perpetrate wrong, and we often entertain these sentiments without discrimination of persons. The leaders of the German people, in control of affairs, civil and military, should be distinguished from the masses, who are responsible for the conduct of their leaders but not equally guilty of moral turpitude. Therefore the penalties imposed should be different.

Care should be exercised in determining geographical boundaries, in limiting productive facilities and capacity, opportunities for development, means for progress and prosperity, the protection against unwarranted attack, racial equality and fraternity, the future preservation, comfort, liberty and general welfare of all the people of all the countries. Friends of today may be enemies hereafter and vice versa. An unfair, unrighteous settlement will not long continue in force. Personally, I do not sympathize with the claims made or reasons given by the German leaders for their acts nor condone their offenses, but I would favor a decision that is fair, wise and Christianlike.

The question of leaving to Germany the facilities and opportunity for production and financial success in order to enable her to pay the large sums which she will be found to owe need not be discussed at this time. The saving from starvation of innocent people in Germany is of higher importance.

Many of us remember with sadness our conferences with German and Austrian steel masters at Brussels. They were agreeable and satisfactory. It is within the bounds of possibility that representatives from all the steel producing countries of the world may hereafter, perhaps sooner than we now expect, meet to consider how best to advance the interests of all. We have never had business differences with any of them which would prevent our welcoming such a meeting. We would be fair, frank and honorable, and, of course, would expect and exact reciprocal treatment.

Believing the war is ended and that peace will soon be declared, we instinctively turn our thoughts to the present and future economic situation. We realize that competition between the business men of this country and those of other countries, and between ourselves, however good natured and friendly, will be persistent and aggressive. So far as the members of this institute are concerned it will never intentionally be wanton and destructive. We have learned the folly and the wrong of such a course. But we believe that the underlying reason for precipitating the late war was economic and that the question which is uppermost in the minds of many if not most of the representatives at the peace conference, is economic, and that a desire for economic advantage and success will actuate the political, financial and industrial administrators of affairs of all countries in future decisions and efforts. We have established friendships with our neighbors across the seas which are genuine and lasting. This will result in benefit to them and likewise to us. But we should not be deluded into the conclusion that any of them will neglect an opportunity to extend influence or to secure trade, or to profit, even

at our expense, so far as the same can be accomplished by legitimate means. This is their right and we cannot reasonably object. However, so far as it is proper, we must be prepared to meet the competition that is sure to appear and we must be diligent, alert and vigorous.

As between ourselves, we believe thoroughly in competition, but in coöperation as often expressed. We believed in this before, during and after the war. It is a principle that will not yield to destructive forces, although it is sometimes selfishly forgotten.

The Business Outlook.

Since the armistice was signed the steel industry has made two substantial reductions in selling prices, first by voluntary action, December 9, and then March 21, after consultation and discussion with the members of the industrial board of the Department of Commerce. There are incidents connected with the efforts of the Secretary of Commerce to stabilize conditions which interfered more or less with business activity. You are familiar with the subject. At present there is a perceptible and gradual improvement. It seems probable this will continue and increase. On the whole, our business during the last six months has been better than we had reason to expect. After what has occurred during the last few years it is wonderful that conditions are so good. As I have said before, more than once, there is a large and fairly profitable business ahead. The necessities of the purchasing public are piling up. Some may wait too long before placing the orders under contemplation. As you are aware, the wheat crop of the season is enormous—far above previous calculations—and it will soon be harvested, threshed, transported and converted into cash. This will provide business and money for the carriers. What they will do with it I cannot say, but they probably will make some necessary improvements in roadbed and equipment. Other crops will soon be coming on. From present appearances the production this year will exceed all former records. The price of copper is increasing. It is expected to be selling in the near future at 20 cents. Most, if not all, of us are making expenditures in preparation for the future business that is coming. It is remarkable how many evidences of business activity there are. Gentlemen, the people of this country are rich and growing richer. It is estimated the wealth of this country is equal to one-third or more of the total wealth of all countries; that there is held by the banks \$15,000,000,000 or \$16,000,000,000; that the money in circulation is about \$56 per capita, as against \$34 before the war. What is it to be supposed will be done with it? Why, invested and expended in order to increase wealth. Perhaps you and I will get some of it, and if so we will expend or invest it for we are like other human beings. There is still room in this country for the optimist, but little space for the pessimist. If the tax assessor and collector will only permit us to retain a little fairer percentage of our earnings we shall be happy; and we are beginning to see a gleam of light on this subject.

Patience and confidence are justified, and, with these, great prosperity is assured.

Optimism Keynote of Institute Meeting

Prominent Speakers Discuss Future Industrial Problems of Steel Industry and Review Steel Production During War—Important Technical Papers Presented—Improved Business Conditions.

The largest meeting of the American Iron and Steel Institute which has ever been held took place at the new Pennsylvania Hotel, New York, May 23. Approximately 1,300 members and guests were present at this meeting, the keynote of which was decided optimism for future favorable business conditions in the iron and steel industry.

Judge Gary's opening address dealt with the pertinent and important topics of interest to steel men at the present time. He favored the league of nations, and spoke seriously of the problems facing the steel industry. He briefly reviewed the work of the iron and steel industry during the war, saying that in every substantial particular the iron and steel industry had made good its promises during the war. He reiterated the previously expressed spirit of confidence of future business conditions and urged the continuance of the same co-operation which the members of the institute had so willingly given during the war. An abstract of Judge Gary's address appears on the first page of this issue.

Judge Gary acted as toastmaster during the evening banquet which was also of record attendance. He introduced Joseph G. Butler, Jr., of Youngstown, as "our Uncle Joe." Mr. Butler reviewed with thoroughness the part played by the iron and steel industry during the war, saying that without American steel the fight for democracy would have been extremely long drawn out with a questionable favorable outcome.

George W. Perkins declared that if business were to be done in France the first steps should be taken

in Washington. He told of meeting 36 business men from Cleveland who were in Paris preparing to open negotiations for business. His advice to them was that they should have first consulted with the government at Washington, it being necessary, in his opinion, that there should be a determination of whether there was in the future to be coöperation or whether

business was to go back to the old basis before the war.

It was necessary, he said, that there should be coöperation. He said inasmuch as we were to have a league of nations for the preservation of world peace, so also we should have a league of classes, a bringing together of capital and labor to discuss the great fundamental principles underlying the industrial structure.

Robert W. Brookings, chairman of the price fixing committee of the War Industries Board, paid a tribute to the steel manufacturers for their war endeavors and said that he was present to express in person the appreciation of the government for the spirit that was shown.

Marcel Knecht, Director of the Official Bureau of French Information, said that it was through the efficiency and vision of the steel manufacturers of America that France had once more attained the gate to liberty. "Two years ago," he said, "I asked

you to bring your steel sword to our help; I ask you today, on behalf of our millions of dead and of wounded, of millions of refugees and ruined populations, to have, like us, like all our great allies, a will of iron in the normal execution of the restitutions, reparations, and guarantees which international justice will impose on Germany. If we had had a Bis-

QUOTATIONS FROM SPEAKERS AT INSTITUTE MEETING.

It is within the bounds of possibility that representatives from all the steel producing countries of the world may hereafter, perhaps sooner than we now expect, meet to consider how best to advance the interests of all.

JUDGE GARY.

The economic situation of France and of Belgium, burned, crippled, and ravaged, is much worse than that of Germany, although France has won an immortal, spiritual, moral and military victory.

MARCEL KNECHT.

Without American steel, the cause of justice and humanity would have been temporarily lost, and the world must needs have stood at arms for generations to come.

JOSEPH G. BUTLER, JR.

When we consider the preparation other nations are making to advance their pecuniary interests in every part of the world we must conclude that to maintain the position which we are entitled to hold we must be unfettered by unreasonable or unnecessary restrictions.

JUDGE GARY.

If we had a Bismarck or a Hindenburg at the peace conference the treaty would have been a treaty of iron; as it is the Allies only are imposing a treaty of broad justice.

MARCEL KNECHT.

The need for patriotism exists today as much as ever and the best reward will come to those who, in dealing with their employes, their customers, and the public, conduct themselves with utmost fairness, with justice to all, and in a spirit of lofty patriotism.

ROBERT S. BROOKINGS.



C. J. WALKER,
Manager forge plant, Gary, Ind.
Author of paper describing the
American Bridge Company's forge
plant at Gary, which appears on
Page 289 of this issue.

marck or Hindenburg at the peace conference, the peace treaty would have been a treaty of iron; the delegates of the Allies are only imposing a treaty of broad justice."

Technical Session.

The technical session was opened by an informal address by S. W. Stratton, director of the United States Bureau of Standards, Washington, D. C. Mr. Stratton's talk was illustrated by lantern slides, showing the laboratories of the bureau and the various types of equipment for conducting research work. Mr. Stratton urged manufacturers to avail themselves of the service which the bureau is rendering in studying special industrial problems. A more complete account of Mr. Stratton's talk appears on page 268 of this issue.

T. F. Bailey, president of the Electric Furnace Company, Alliance, O., presented a paper entitled "Electrically Heated Soaking Pits and Heating Furnaces." Moving pictures and lantern slides were used to illustrate the paper which was later discussed by W. G. Kranz, vice president of the National Malleable Castings Company, and by Prof. J. W. Richards, of Lehigh University. Mr. Bailey's paper appears on page 289. The morning session was concluded by a paper read by C. J. Walker, manager of the American Bridge Company's forge plant at Gary. The speaker described briefly the construction and equipment of the new forge plant at Gary.

An exceedingly interesting description of the Clairton by-product coke ovens was given by Frank F. Marquard, superintendent of that plant. The author of this paper during his talk showed a moving picture made from a sectional drawing of the entire plant. The original of this drawing, incidentally, was 42 feet long and was prepared at an expense excessive of \$1,000. Presenting a complete sectional view of the world's largest by-product coke plant, this drawing is a most valuable contribution to the fund of information concerning by-product coke ovens. It is regrettable that the drawing is too large to be conveniently reproduced in connection



J. A. MOHR,
Superintendent Carnegie furnaces, Car-
negie Steel Company, Rankin, Pa.
Author of paper on methods of
charging raw materials into the
blast furnace, which appears on
Page 298 of this issue.

with Mr. Marquard's paper which appears on page 256 of this issue. The author showed a large number of views of the plant in addition to the sectional view. This paper is probably one of the most comprehensive descriptions of an existing by-product coke oven installation which has ever been prepared.

The next paper on the program was presented by Henry D. Hibbard, consulting engineer, Plainfield, N. J. The subject of his paper was the "Present Status of Non-Metallic Impurities of Steel." Mr. Hibbard in discussing this subject, pointed out that sonims are particularly liable to occur in Bessemer and open hearth steels, the crucible and electric processes being less liable to contain these impurities. The author classified the various cases of sonims and discussed their occurrence.

The author then reviewed briefly the relation of sonims to the Bessemer, acid open hearth, basic open hearth, crucible and electric processes. In conclusion Mr. Hibbard stated that "to forecast the effect of sonims on the properties of steel, there is much work to be done and interpreted, but it may be said that one must know their quantity, composition and manner of distribution or occurrence in the steel. The quantity and composition must be determined by chemical means, and the mode of occurrence as far as may be by the microscope. The experience of McCance and others shows the importance of the subject and the need of further study, investigation and experience to find the answers to the many questions which may arise."

This paper was discussed by L. B. Lindemuth, of Carney & Lindemuth, New York, who pointed out the means by which non-metallic impurities occur from sources outside of the steel.

John S. Matthews, president of the Halcomb Steel Company, Syracuse, N. Y., in discussing Mr. Hibbard's paper, said in part:

"The committee on aircraft engine forgings, of which I was chairman, came to the conclusion that so-called 'hair lines' were due to sonims, elongated in the direction of rolling or forging. They varied much in length and visibility. Sometimes they were seen only on the ground and polished surface with a magnifying glass. Actual grinding tests and count of hair lines on cylindrical surfaces of chrome nickel steels of the type represented by 3.5 per cent nickel, 0.75 per cent chromium, and 0.35 per cent carbon were made. Steels to the same specification were made in the basic open hearth, acid open hearth and basic electric furnace. The relative average count was respectively 46, 23, and 6, and it was further noted that the hair lines were in general, much shorter and inconspicuous in the electric product than in either class of open hearth products."

S. L. Kelley in further discussing this paper, pointed out that "the cost of steel will often determine the amount of effort which can be put upon the manufacture. Low price steel must of necessity be manufactured without too great elaboration of the processes, and, accordingly, it will contain larger amounts of these objectionable impurities. With higher grade steels, where the increase in cost incident

to greater care in manufacture is not a too serious obstacle, all possible precautions must be observed. These precautions in open-hearth furnaces will generally lead to the selection of acid furnaces in preference to basic furnaces."

Frank B. Poto, of the Otis Steel Company, Cleveland, O., in discussing the same paper added: "In my experience, the addition of ferro-manganese to the furnace bath instead of to the ladle has always been followed by a marked improvement in the quality of the steel, provided the heat was held in the furnace long enough for the purifying reactions of the manganese with the oxides to take place. No doubt this improvement is due largely to a more complete elimination of sonims and sonim producing compounds, by reduction of the oxides and fluxing of the silicates. That this is largely the case is proven by the great loss of manganese, (especially when the ferro-manganese is added to the bath), in a poorly worked heat, and by the comparatively small loss when the heat is properly worked.

"As a further means of eliminating sonims, I have in mind a process which is being used to produce a deoxidized basic open hearth bath. This simply consists in thickening up the slag, (starting about an hour before ready to tap), by the gradual addition of burnt dolomite or magnesite. By such a procedure, the normal basic slag is diluted by a non-oxidizing base, lime and magnesia, and it soon becomes very viscous."

A very comprehensive paper entitled "Standardization of Ship Building Materials," was prepared and read in abstract by F. T. Llewellyn, of the Federal Shipbuilding Company and the Chickasaw Shipbuilding Company:

Emphasizing the importance of distinguishing between standardization of types, designs and materials, Mr. Llewellyn pointed out that while the possibilities of standardizing the various types of ships might be limited by differing conditions of routes, harbors, and service, yet standard ranges and grades of material can be applied to any ordinary types and designs, and that this feature was of special concern to the members of the American Iron and Steel Institute, particularly as regards hull steel. He devoted the body of his paper to an outline of the need, history, and possibilities of standardization in connection with the materials required for freighters, whose steel hull structures, constitute some 75 per cent of the weight and 50 per cent of the cost of the entire ship.

He compared ship requirements with those of rolling stock and bridges, defining a ship as a storm-tossed box girder, a freight tank, a power house, and a floating hotel, all combined. He said in part: "The popular notion that her stresses are indeterminate is no more correct than in the case of fixed steel structures. The origin of design in both classes of structures was an accumulation of empirical rules, and in both cases theory has simply afforded an intelligent means of comparing the probable safety of an untried design with one whose behavior is known. The Titanic is matched by the Tay and the Quebec bridges."

"Methods of Charging Raw Materials into the Blast Furnace," was the title of a paper read by J. A. Mohr, superintendent Carrie Furnaces, Carnegie Steel Company, Rankin, Pa. This paper appears in full on page 298 of this issue. Mr. Mohr's paper was discussed by R. W. H. Atcherson, blast furnace superintendent, Inland Steel Company, Indiana Harbor, Ind., who referred to his experience with furnace

tops saying that "remarkable blast furnace results have been attained on stationary top furnaces proving satisfactory distribution for the grade of raw materials used. If their raw materials had been of less excellent quality the need for rotating the top might easily have become a serious factor. The rotating tops have given excellent results on the Inland Steel Company blast furnaces. During the present business depression No. 2 furnace was blown-out after producing 1,041,970 tons of iron at a daily average of 525 tons and coke practice of 1881 pounds. This is not claimed to be a phenomenal record but we were surprised to find that the hearth, bosh and practically all of the stack lining had been worn back very uniformly about five inches.

Mr. Atcherson also said: "I would like to add to Mr. Mohr's testimony that I have seen mixed filling substituted for stratified filling at a number of blast furnace plants using Mesaba ores, with beneficial results in every instance. The gaseous current or indirect reducing agent of the furnace physically as well as chemically seeks the particle of ore which it is destined to reduce and it is only by the proper mechanical preparation of the charge that the intimacy of contact is afforded to produce the most efficient blast furnace practice."

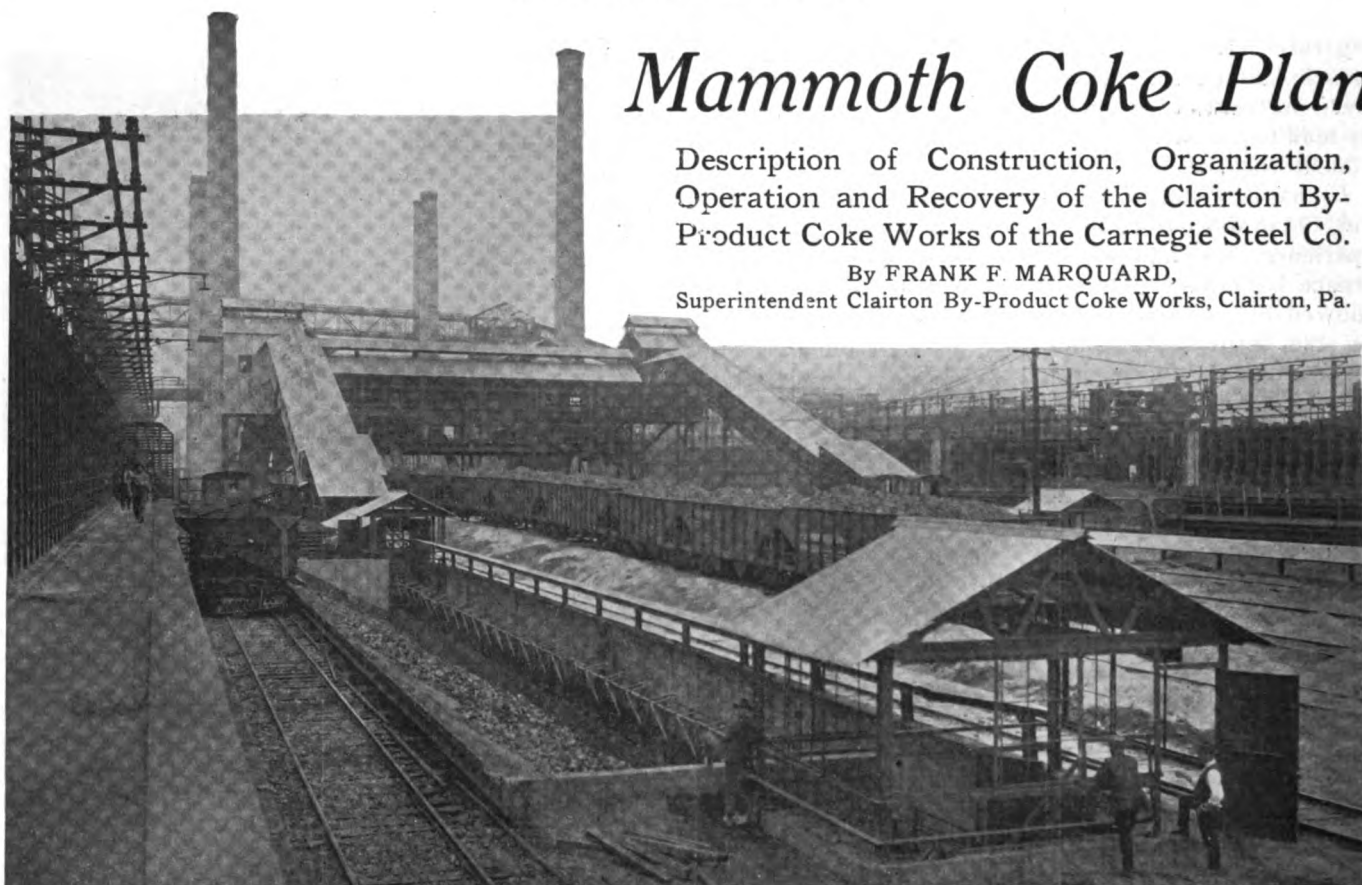
Harry S. Braman, superintendent of blast furnaces and steel department of the Youngstown Sheet and Tube Company, in discussing Mr. Mohr's paper, described the local conditions at Youngstown. R. M. McKay, superintendent of blast furnaces at the Bethlehem Steel Company, also discussed Mr. Mohr's paper.



T. F. BAILEY,
President The Electric Furnace Company. Author of paper entitled "Electrically-Heated Soaking Pits and Heating Furnaces." The major portion of this paper appears on Page 264 of this issue.



FRANK F. MARQUARD,
Superintendent Clairton by-product coke ovens, Clairton, Pa. Author of paper, "The Clairton By-Product Coke Ovens." The first installment of this paper appears on Page 256 of this issue.



Mammoth Coke Plant

Description of Construction, Organization, Operation and Recovery of the Clairton By-Product Coke Works of the Carnegie Steel Co.

By FRANK F. MARQUARD,
Superintendent Clairton By-Product Coke Works, Clairton, Pa.

The Clairton by-product coke plant, without exaggeration, stands today as the crowning climax in the development of the by-product coke oven industry of the world. It is the most comprehensive in plan of operation; the largest in size; in detail of construction the most complete; and the most efficient in recovery.

By-Product vs. Beehive.

The delayed recognition, however, of the merits of the by-product coke oven industry has resulted in enormous waste. In the past 25 years, in this country, the beehive ovens have wasted in tar and gas, reduced to coal equivalent, an amount equal to over 300,000,000 tons of coal, and a waste of over \$400,000,000 worth of ammonia (at 5c per pound NH_3), and over \$500,000,000 worth of benzol products at 10c per gallon.

The beehive oven is primitive, crude, wasteful, and, in the light of the present day experience in the operation of by-product ovens, the beehive oven will soon play a very minor part in the coke production of the country.

In the past few years there has been a wonderful awakening. The construction of by-product ovens has been greatly extended. Its merit as an essential industry in time of war, as well as peace, is now recognized by our government as of national interest, as well as of economic interest in the development of the iron and steel industry.

In the year 1918, 60,000,000 tons of coke were produced in this country, 30,000,000 by the by-product

coke ovens and 30,000,000 by the beehive ovens, and this year, 1919, will mark the turning point in favor of the production of by-product coke.

In planning the construction and operation of this large plant, three important questions were very carefully considered:

Location so as to effect maximum economy in transportation of coal, gas, and coke.

Type of oven and recovery apparatus most effective for the production of the best metallurgical coke from the coking of 100 per cent high volatile coal.

Market for the coke, tar, gas, ammonia, benzol, coke dust and domestic coke.

As to location, we have been extremely fortunate

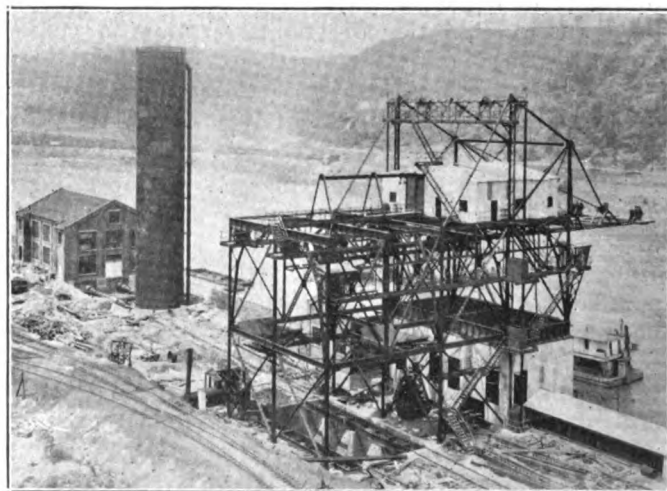


Fig. 1—Coal hoist No. 2, Monongahela river and stand pipe and pumping station in the rear.

From paper read before May meeting of the American Iron and Steel Institute.

in having a site located north and adjacent to the Clairton steel plant of the Carnegie Steel Company. This site is 5,200 feet long and 1,800 feet wide; along the western shore of the Monongahela river, 20 miles south of Pittsburgh, and large enough for the construction of 24 batteries of 64 ovens to the battery.

Twelve batteries, 768 ovens, are completed, with a daily coal consumption of 12,500 net tons of coal per 24 hours.

Daily Production and Yield From 12,500 N. T. Klondike (Fayette County) Coal Per 24 Hours.

Daily Production.	Per Cent Yield—Based on Coal Charged.
8,000 N.T. of dry screened furnace coke ($2\frac{1}{2}\%$ H ₂ O)	62 %
520 N.T. small size coke (Domestic Coke).....	4.2%
900 N.T. Coke Dust	7.2%
150,000 Gals. Coal Tar	12 gls. pr N.T. coal
162 N.T. Sulphate of Ammonia	25 lbs. pr N.T. coal
29,000 Gals. Pure Benzol	2.3 gls. pr N.T. coal
7,400 Gals. Pure Toluol	.57 gls. pr N.T. coal
2,800 Gals. Crude Light Solvents	.22 gls. pr N.T. coal
1,400 Gals. Crude Heavy Solvent	.11 gls. pr N.T. coal
75,000,000 Cu.Ft. Surplus Gas (575 Btu)6,000	cu.ft. pr N.T. coal

industry springs up. Instead of distilling corn and rye into alcoholic liquors, we have built a plant to distill coal into ammonia liquor, gas, sulphate and tar; benzol, toluol and its homologues; and last, but not least, a valuable residue left in the oven after the distillation has been completed, known as by-product coke and which has proven superior to the long silvery needle of beehive coke, as a metallurgical fuel. Such are the great strides in the development of an industry which today stands as a monument of scientific achievement in the progress of modern civilization.

The coking of 100 per cent high volatile coal had not yet passed beyond the experimental stages and considerable interest was centered upon the performance of the blast furnaces using this by-product coke made from 100 per cent high volatile coal. The performance of the Clairton Steel Works blast furnaces were first to demonstrate that the coke could be used successfully in place of beehive coke, for, not only did these furnaces increase their production of pig iron, but did so on a lower coke consumption, and the larger

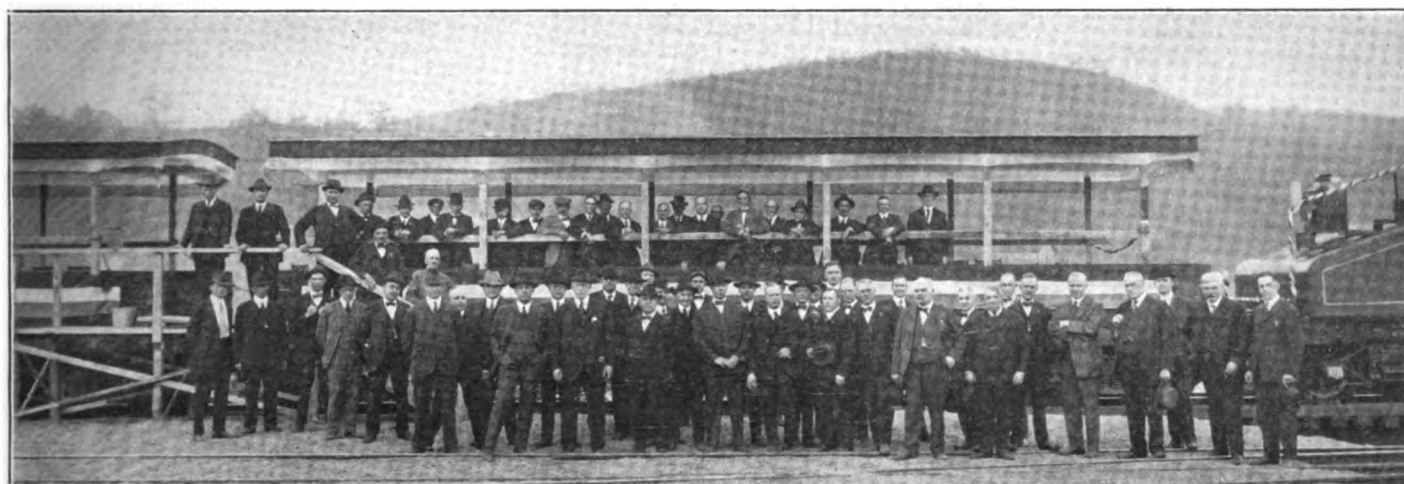


Fig. 2—President Farrell, of the United States Steel Corporation, and President Williams of the Carnegie Steel Company, leading inspection party during construction of by-product coke plant, accompanied by general superintendents of Carnegie Steel Company, and local superintendents of by-product coke plant and steel plant.

In order to handle these large quantities of coal and coke, we found it necessary to construct a river fleet of 120 barges and seven tow-boats to transport our coal from the mines to the ovens; eight miles of main line track and twenty miles of yard track; a 40-inch diameter gas line, nine miles long to deliver the gas to Duquesne, Homestead, Edgar Thompson and Clairton steel works. Seventy-five 10,000 gallon tank cars for tar and benzol; 500 steel hopper coke cars; coal storage yard of 250,000 net tons capacity, to take care of a possible interruption in our river traffic in winter months and to assure uniform oven operation, etc.

This particular location has considerable historic interest. It was the battlefield of the Whiskey Insurrection in 1794, when Washington's army came upon the scene to enforce the payment of the excise tax levied upon whiskey. It was here where the whiskey industry was born (1794) and greatly developed, and for 125 years prospered, and now, July 1, 1919, after it has reached its highest stage of development, will be summarily brought to a close and in its place a new

blast furnaces of Duquesne and Edgar Thompson, after some preliminary adjustments, quickly responded by increased production and low coke consumption in a manner most satisfactory.

In the description of this complete by-product plant it is difficult to convey a true conception of its size and operation, and I have therefore supplemented my paper with motion pictures to show upon the screen operations which would take many pages to describe.

To follow the plant construction in its sequents of operation, I have started at the coal hoists.

The Clairton plant is equipped with two electrically operated coal hoists, each hoist consisting of two 5-ton hoisting buckets having a lifting capacity of 500 tons per hour. The coal is lifted from the barges and dropped into a 150-ton hopper from which it is spread over a shaking screen to roll crushers. This screen has slotted openings $2\frac{1}{2}$ x11 inches and the crusher rolls are set 2-inch openings, so that approximately 60 per cent of the coal passes through the shaking screens, the oversizes going through the rolls,

leaving the rolls to crush only the larger lumps. Thus we are able to secure a maximum density of coal, i.e. there is always sufficient fines present in the coal to fill up the voids however coarse the coal may be crushed and experiments have shown that by this method of crushing we are able to secure a coal of maximum density. Coal crushed in this manner will average 53½ pounds per cubic foot, while coal pulverized by hammer mills will average 6 to 8 per cent less per cubic foot.

If we had been forced to resort to a mixture of low volatile coal it would have been necessary to crush all

incline to the bunkers. The 12-battery plant is equipped with four bunkers, each bunker having a capacity of 4,000 tons of coal. Each bunker supplies three batteries. The coal is drawn from the bunker into larry cars. These larry cars are equipped with four cone-shaped hoppers, the capacity of these being just sufficient to fill one oven which requires 13.3 net tons of coal per charge. It is important in the charging of the ovens to see that the oven is charged to its fullest capacity, for the reason that not only do we secure thereby the maximum production of coke per oven, but we limit the gas space in a manner which allows

CLAIRTON BY PRODUCT COKE WORKS DATA SHEET

STATEMENT SHOWING PRODUCTS RECOVERED FROM 100% CRUSHED KLONDIKE COAL

SIZE OF OVENS

17" WIDE PUSHER SIDE
19½" COKE SIDE
9' 10" HEIGHT OF OVEN
9' 0" COAL
37' 0" LENGTH OF OVEN

CAPACITY

500 CU. FT.
13.4 TONS PER
CHARGE @ 53.7 LB.
PER CU. FT. OF COAL

ONE NET TON OF COAL

1240 LBS. SCREENED FURNACE COKE (25% H₂O) (62% YIELD) .57 GALS. PURE TOLUOL
140 " DUST .22 GALS. CRUDE (1) LIGHT SOLVENT
80 " DOMESTIC .11 " (2) HEAVY
25 " SULPHATE OF AMMONIA .10 LB. CRUDE NAPHTHALENE
12 GALS. TAR 5600 CU. FT. GAS SURPLUS (DEBENZOLIZED)
2.3 " PURE BENZOL 4600 " " FUEL (DEBENZOLIZED)

COATING TIME HOURS	NET TONS COAL PER OVEN PER 24 HRS	NET TONS FURNACE COKE PER OVEN PER 24 HRS	TOTAL NET TONS COAL 768 OVENS PER 24 HOURS	PRODUCTION PER 24 HOURS BASED ON 768 OVENS										NET TONS CRUDE NAPHTHALENE	1000 CU. FT. OF	
				NET TONS FURNACE COKE	NET TONS COKE DUST	NET TONS DOMESTIC COKE	NET TONS SULPHATE OF AMMONIA	GALLONS TAR	GALLONS PURE BENZOL	GALLONS PURE TOLUOL	GALLONS LIGHT SOLVENT	GALLONS HEAVY SOLVENT	SURPLUS GAS 55%		OVEN FUEL GAS 45%	
18	17.87	11.08	13,724	8,509	961	549	171.6	164,688	31,565	7,823	3,019	1,510	.686	76,854	63,130	
19	16.93	10.50	13,002	8,061	910	520	162.5	156,024	29,905	7,411	2,860	1,430	.650	72,811	58,809	
20	16.08	9.97	12,349	7,657	864	494	154.4	148,188	28,403	7,039	2,717	1,358	.617	69,154	56,805	
21	15.31	9.49	11,758	7,290	823	470	147.0	141,096	27,043	6,702	2,587	1,293	.588	65,845	54,087	

ANALYSIS OF COAL AND PRODUCTS

COAL	FURNACE COKE	DOMESTIC COKE	COKE DUST	GAS	TAR	SULPHATE OF AMMONIA	PURE BENZOL	PURE TOLUOL	CRUDE (1) LIGHT SOLVENT	CRUDE (2) HEAVY SOLVENT	NAPHTHALENE (CRUDE)		
MOIST. 2.58	2.35	7.01	9.85	CO ₂ 1.7	WATER 12.5%	WATER 2.00	DISTILLATION	DISTILLATION	DISTILLATION	DISTILLATION	DRY MELTING		
V.M. 34.04	.72	1.06	1.12	ILL 3.0	LIGHT ACID	ACID .35	START 79°C	START 109°C	START 125°C	START 135°C	POINT 72°C		
F.C. 57.26	87.64	84.77	81.59	O ₂ .0	WATER 9.6%	NH ₃ 25.10	5% OFF 50°C	5% OFF 109°C	5% OFF 130°C	10% OFF 160°C	RESIDUE 3%		
A.M. 8.70	11.44	14.17	17.29	C.O. 3.5	HEAVY 10.5%		90% OFF 80°C	90% OFF 110°C	90% OFF 140°C	90% OFF 200°C	7% OFF AT		
SUL 1.28	.87	.77	1.15	CH ₄ 34.6	WATER 21.50		DRY 80°C	DRY 110°C	DRY 185°C	DRY 210°C	200°C		
PHOS. .014	.020	.022	.022	N ₂ 53.9	PITCH 58.50	LIBERTY	WASH "A	WASH "A	LIGHT	LIGHT			
BTU 13,157	*12,622	*11,666	*10,288	N ₂ 3.3	COKE 18.00	QUALITY	OR UNDER	OR UNDER	STRAIN COLO	STRAIN COLO			
				SP GR .34	SP GR 11.55	WATER. 10							
				(BTU 570)	(BTU 1600)	ACID .15							
				PER CU FT	PER LB	NH ₃ 25.60							
				SAFETY 818	PER CU FT	F.C. 4.25							
				SUL .35									

REVISED 5-9-19

* DETERMINED ON NET BASIS

Average analyses of coal, coke and by-products showing yields and total daily plant capacities of 768 oven plant.

of the coals to a small size in order to effect a thorough mixture. It has been demonstrated that the sizes to which the coal is crushed (a factor determining the density) has a direct influence on the quality of the coke and this important point in the operation of the coke plant should receive very careful consideration. In the use of 100 per cent high volatile coal, that is volatile 33 to 35 per cent, I am convinced that the denser the coal charge the better the quality of coke.

The coal after it leaves the crusher is mixed with the fines that pass through the shaking screens and is fed on a rubber belt then conveyed up a 15 degree

the gas to pass out of the oven quickly without lingering in contact with heated walls, such as would be the case where ovens are irregularly filled. The charging and leveling of the coal in the oven requires approximately one and one-half to two minutes, during which time the gasses are allowed to escape. As soon as the coal is leveled the lids are properly secured and the gas from the ovens is then allowed to pass up through the ascension pipe into the collecting main.

The ovens are Koppers standard 500 cubic foot ovens, 37' 0" face to face of doors, 17" wide on the pusher side and 19½" wide on coke side, 9' 10" floor

to roof and 9' 0" floor to top of coal when charged.

Each battery of 64 ovens is made up of 232 different silica shapes and 98 clay shapes. The total 9"-brick equivalent for each battery is approximately 2,529,000 brick.

The ovens are individual cross-regenerative type, having 16 vertical flues on the pusher side and 14 vertical flues on the coke side, all connecting into a common horizontal flue near top of oven. Each oven has two independent air regenerating chambers filled up with $9 \times 3 \times 3$ " and $9 \times 2\frac{1}{2} \times 2\frac{1}{2}$ " clay brick and $9 \times 2\frac{1}{2} \times 2\frac{1}{2}$ " silica brick, having a total mass of approximately 164 cubic feet in the pusher side chambers and approximately 152 cubic feet in the coke side chambers. The bottom tier of regenerator brick are $9 \times 3 \times 3$ " clay brick so laid that the gas space between the bricks varies from $\frac{1}{4}$ of an inch on outlet side of chamber to $\frac{1}{2}$ inch at far end of chamber to more equally distribute the air through the checker work. All other brick are $9 \times 2\frac{1}{2} \times 2\frac{1}{2}$ " clay brick, except the top five courses which are $9 \times 2\frac{1}{4} \times 2\frac{1}{2}$ " silica brick.

That proportion of the gas which is returned to the ovens as fuel is delivered to each battery through a Venturi meter and then to a 20" O.D. main on each side of the battery. From the fuel gas main it is introduced alternately to each side of the ovens through gun brick made up of clay shapes having a 4" diameter hole and suitable outlets on top to receive a nozzle brick for each vertical flue. The openings in the nozzle brick are semi-elliptical and vary from .49 sq. in. to .35 sq. in., increasing towards the center, furnishing a means of taking care of the pressure drop in gun brick and the changed volume of the heated gas. The nozzle brick in the end flue, on each side, are of large size to make up for radiation losses caused by the oven doors.

The air for combustion enters the regenerator chambers under suction through air valves in the connection between the bottom regenerator chamber and the side stack flue. This inlet is opened and closed by the automatic reversing mechanism, being open when the reversing damper on the same side is closed. The amount of air entering can be controlled at this point by more or less restricting the opening by the use of strips of steel called finger bars. The air passes up through the regenerators, is heated to 1,700 degrees F. and enters the vertical flues, where combustion takes place. These air openings into the vertical flues are 6.213 sq. in. in area, except the end of the flue which is 9.281 sq. in., to supply additional air for the greater amount of gas burned in the end flue. Each vertical flue is continued above the horizontal flue to the top of the battery where it is covered by a cast iron cap. This cap furnishes a means of inspecting each flue and also a means of changing nozzle brick or sliding brick settings.

The opening from each vertical flue into the common horizontal flue is regulated by a sliding brick in order to secure uniform pressure condition in each vertical flue. The gas is burned up the vertical flue in a manner so that the tip of the flame extends approximately 24" from the top horizontal flue.

The products of combustion are conducted from the vertical flues on one side of the oven into the

horizontal flues, across and down through the vertical flues on the other side and through air ports into opposite regenerator chambers where the gas is robbed of most of its sensible heat. From the regenerator chamber the waste gas is conducted through the air box to the stack flue, thence to the stack. On 19 hour coking time the average vertical flue temperature on low heated coke is 2,300 degrees F.

The draft on individual ovens is controlled by a butterfly damper in each air box, connecting the regenerators with waste gas flue leading to the stack. The butterfly dampers are set wide open for the regenerator farthest away from the stack end and gradually contracted toward the stack so that each regenerator of the entire battery of 64 ovens is under the same draft conditions, individual ovens, however, may be given more or less gas to compensate for variable conditions that may exist.

The stack flues parallel each side of the battery, uniting into a single flue at the reversing end of the battery, thence to the stack. The stacks built of reinforced concrete, brick lined, are 8' 6" in diameter and 200' 0" high. At a point near the junction of the two main flues, each flue has a reversing and regulating damper. The reversing damper, during operation, being either wide open or closed, according to the side the gas is burning on. The regulating dampers have hand control and when once set are left in position as long as the desired differential exists between the two flues. The main stack flue has a hand-regulated damper by which the draft may be regulated, effecting both flues without effecting the distribution of draft between the coke and pusher side flue.

Summary of the Points of Variable Control.

- (1) Pressure of gas in fuel gas main on each side of battery.
- (2) Size of opening in nozzle brick in each vertical flue.
- (3) Setting of sliding brick at top of each vertical flue.
- (4) Setting of draft butterfly dampers in air boxes from stack flues.
- (5) Setting of regulating dampers in pusher and coke side stack flues.
- (6) Setting of regulating damper in main stack flue.
- (7) Number of finger bars in air inlet to regenerators.

It can readily be seen that these points of regulation are all more or less inter-dependent and furnish a very flexible means of control.

The gas is reversed every half hour by a clock energizing a motor driven master control. First—The gas is shut off by closing individual valves in the line from the fuel gas main to the gas gun. The valves on either side of the battery are all connected by a rod and cable to separate gas cock machines. Second—The reversing dampers are reversed, the same machine reversing the air opening in the air box. Third—The gas cocks on the opposite sides are opened. The gas is put on by the gas cock machine releasing cable allowing counterweight to open cocks. The gas is

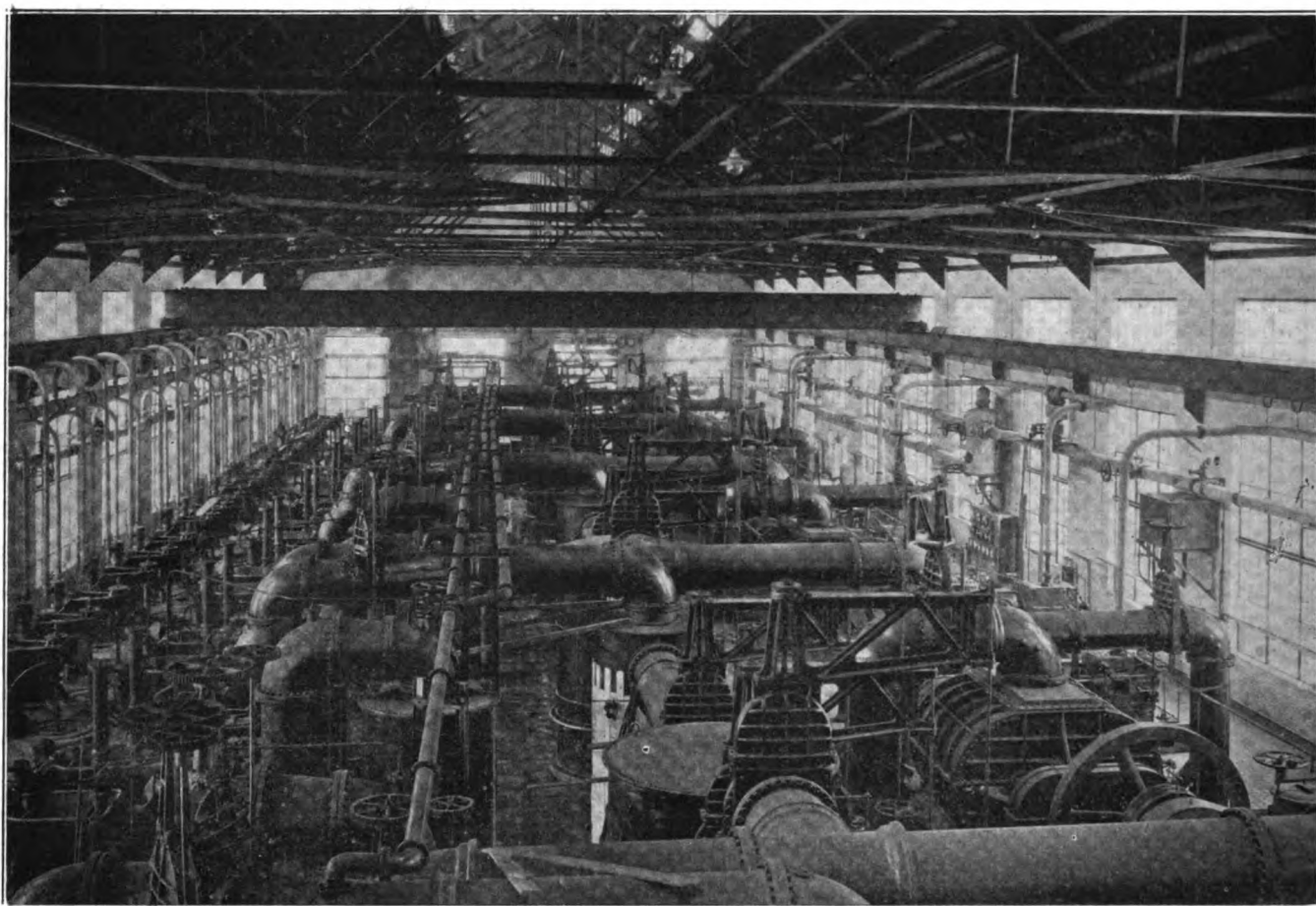


Fig. 3—Interior view of by-product building.

taken off by the machine pulling against the counterweight and is positive in action.

The various steps in reversing are so timed that enough time interval is allowed between each operation for the flues to clear themselves of any explosive mixtures. Every operation, reversing, gas pressure, temperature, gas consumption, etc., is recorded by clock recording instruments.

Inasmuch as the gas is introduced through the gun brick and nozzles, located in such position in the oven that they become heated to a point high enough to break up some of the fuel gas with the deposition of carbon, it is necessary to provide means of decarbonizing them. This is done by opening the cap on each gas gun several minutes after reversal on the opposite side, from which the gas is burned, allowing air

to be drawn into gun brick and nozzles, burning the heated carbon.

The Following Are Clairton Average Settings and Readings on 19 Hour Coking Time.

Gas pressure on pushing side, 40 mm of water.
 Gas pressure on coke side, 50 mm of water.
 Stack draft on pusher side, 21 mm of water.
 Stack draft on coke side, 22 mm of water.
 Temperature of waste gas at base of stack, 275 degrees C.
 Gas burned per hour pusher side, 180,000 cu. ft.
 Gas burned per hour coke side, 200,000 cu. ft.
 Back pressure in collecting mains, 2.5 mm of water.
 Average draft at top of regenerator chamber, pusher side, .36" water.
 Average draft at top of regenerator chamber, coke side, .40" water.
 Opening in air inlet to regenerators, pusher side, 84.7 sq. in.
 Opening in air inlet to regenerators, coke side, 59.7 sq. in.

Nozzle Brick Settings.

	Sq. In.		Sq. mm
Flue 1 Coke side (end flue).....	.49	or	316.05
Flue 2 to 12 incl., coke side.....	.35	or	225.70
Flue 13 and 14, coke side.....	.38	or	245.10
Flue 1 pusher side (end flue).....	.35	or	225.7
Flue 2 to 12, pusher side inclusive.....	.35	or	225.7
Flue 13 to 16, pusher side inclusive.....	.38	or	245.1

Sliding Brick Settings.

Flue No. 1, coke side (end flue).....	full open	17.721
Flue No. 2, 3, 4, coke side.....	60 mm	8.103
Flue No. 5, 6, 7, coke side.....	55 mm	7.256
Flue No. 8, 9, 10, 11, 12, coke side....	50 mm	5.874
Flue No. 13, 14, coke side.....	45 mm	5.119
Flue No. 1, pusher side (end flue)....	full open	17.721
Flue No. 2, 3, 4, 5, pusher side.....	60 mm	8.103
Flue No. 6, 7, 8, pusher side.....	55 mm	7.256
Flue No. 9, 10, 11, 12, pusher side....	55 mm	6.615
Flue No. 13, pusher side.....	50 mm	5.874
Flue No. 14, 15, 16, pusher side.....	45 mm	5.119

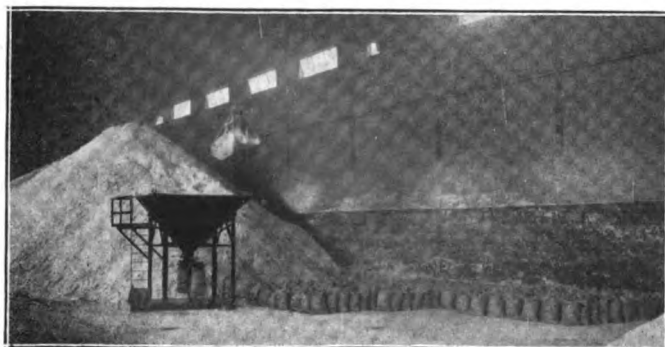


Fig. 4—Ammonia sulphate storage room.

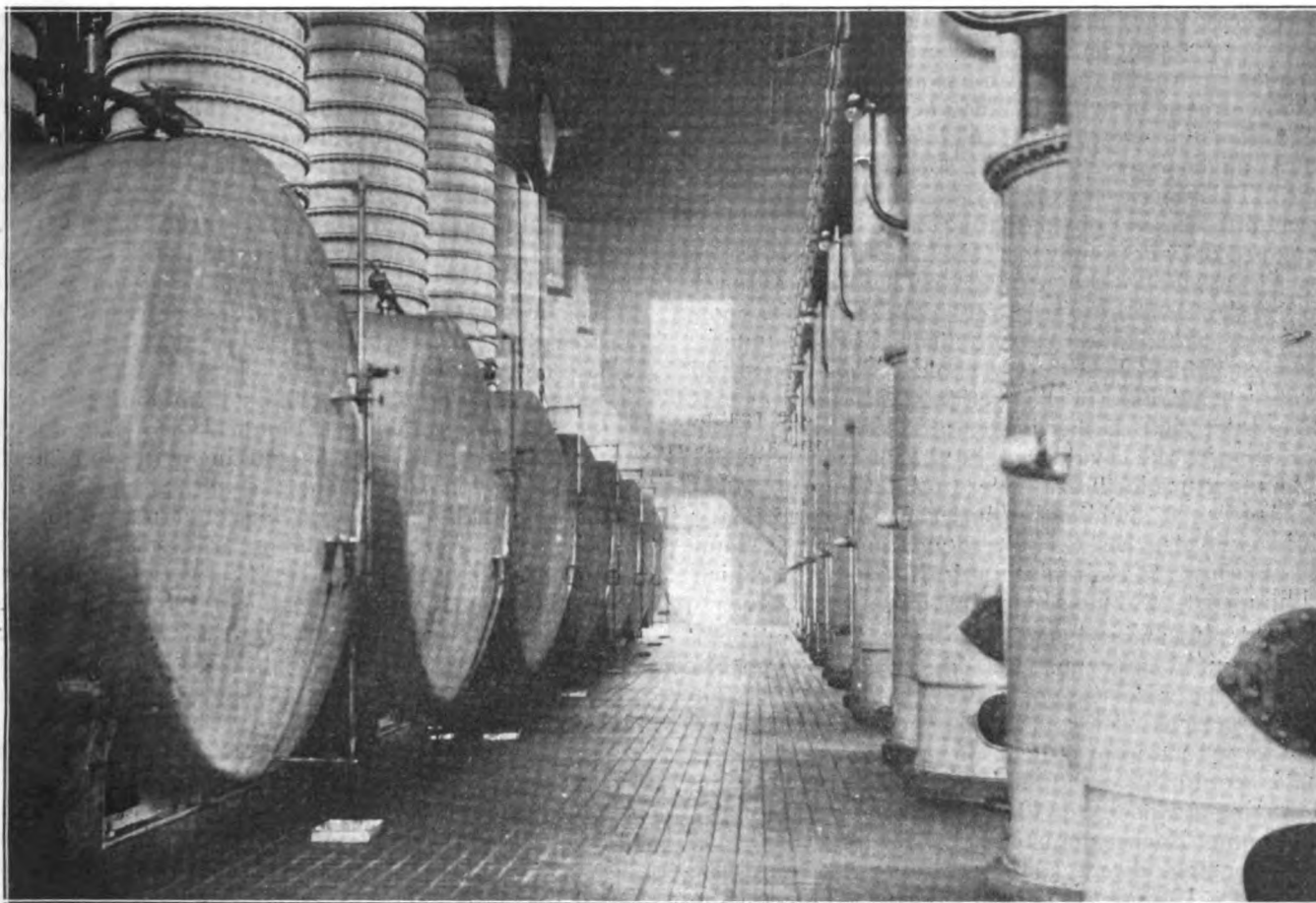


Fig. 5—Interior view of benzol building, showing wash oil stills in one row and pure and crude benzol stills in the other.

After the volatile matter is all driven off of the coke, which is completed in 19 hours, the doors are removed and the coke is pushed into the quenching car and is brought under a spray of water and quenched for 45 seconds. In order to quench this coke in this time 6,000 gallons of water per quench is required, 1,000 gallons of which is evaporated. It is important to quench this coke in a manner which will give a coke containing not more than 3 per cent of water. The coke is then allowed to drain one minute and dropped upon a wharf from which it is fed, by a rotary feed, to a rubber belt, passed over a stationary bar grizzly screen, made up of hard iron bars set with space $\frac{7}{8}$ " top and $1\frac{1}{4}$ " bottom, six sets of bars, each bar 24" long, and through chutes into cars. The fines passing through the grizzly screen amount to approximately 18 per cent of the total coke discharged from the oven. These fines are rescreened through a rotary screen with $\frac{3}{4}$ " wire mesh openings, where the larger sizes are separated from the dust. The larger sizes are available for domestic fuel, while 80 per cent of the dust is required to produce all the steam requirements for the entire coke and benzol plants.

The gas coming from the ovens enter a collecting main through ascension pipes and mushroom valves. The collecting main is U shaped and so designed as to give the gas a speed of approximately five feet per second, and the suction main is so designed as to give a speed of travel of approximately 15 feet per second. In order to maintain uniform gas pressure in the col-

lecting main a butterfly regulating valve is inserted in the suction main and is controlled by an electric contrivance known as a Northwestern governor. This valve is set so as to hold a pressure in the collecting main at $3\frac{1}{2}$ mm of water.

The gas leaves the ovens at an average temperature of 600 degrees C., enters the collecting main at 400 degrees C. and leaves the collecting main to the suction main at 200 degrees C.

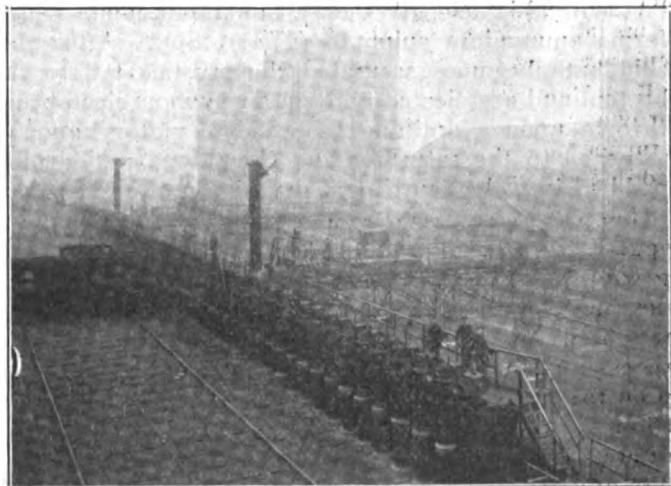


Fig. 6—Showing top of batteries, Larry charging car, gas ascension pipe connections to collecting main, suction mains and Northwestern control governor—Wash oil scrubbers in the rear.

The heavy tars are quickly condensed and drop out in the collecting mains, and in order to prevent this pitchy tar from building up and stopping the mains, a constant stream of what is known as flushing tar is flooded through these mains. This flushing tar is a mixture of 50 per cent tar and 50 per cent ammonia liquor. This carries the heavy tar and such pitch as is formed to the end of the main, where the hard pitch is screened out and removed. The gases in their travel from the ovens to the primary coolers are reduced from 200 degrees C. to 75 degrees C. During the cooling, 70 per cent of the tar is condensed in the collecting mains before the primary coolers are reached, 20 per cent is condensed in the suction mains and approximately 8 per cent of the lighter tars, and most of the water vapors, are condensed in the primary coolers. The temperature in the gas inlet to the primary coolers is 75 degrees C., while the outlet from the primary coolers is 28 degrees C. The liquor and tar is combined and flows to a circulating drain tank from which it is pumped to the tar separating tank.

In order to maintain uniform operating conditions it is extremely important that the even temperature control of the gases be constantly maintained. After the gases are passed through the primary coolers, they are under a suction of 30 c.m. of water. The Clairton plant is equipped with five Connersville exhausters, each having a capacity of 40,000,000 cu. ft. per 24 hours at 100 r.p.m. Each exhauster is driven by two simple, non-condensing, direct connected, Hamilton engines, built by the Hooven, Owens & Rentschler Company.

After passing through the exhauster, the gas is raised in temperature by compression, from a suction of 15 inches of water to a compression of 50 inches of water. The gas is then passed through the tar extractors which eliminates the last traces of tar vapors by mechanical means, i.e., forcing the gas through finely perforated plates and allowing it to impinge upon a flat surface, which breaks up the little tarry mist into globules. The gas, thus free from the tar, is preheated to a temperature of 60 degrees C. and then passed through the lead lined saturators containing a solution of 5 per cent sulphuric acid. The gas coming in contact with this acid gives up all of its ammonia which forms ammonium sulphate $(\text{NH}_4)_2\text{SO}_4$. After this acid bath becomes saturated the crystals fall to the bottom and are ejected with an air syphon ejector and thrown upon a draining table. The motor liquor is returned to the saturator and the salt is periodically paddled into the centrifugal dryer.

These dryers are 40 inches in diameter and have a copper screen perforated with 5/64-inch holes, backed up with No. 18 gauge, 11 strands to the inch, copper wire mesh, with copper screen perforated with 5/16-inch holes on the outside, and during the drying process are speeded up to 650 r.p.m. The salt is built up on the walls of this centrifugal dryer to the extent of four or five inches and is whizzed for a period of 15 minutes, after which it is washed with a small quantity of hot water and whizzed for another few minutes. The dryer is then stopped and the salt is scraped off the copper screen with copper paddles and dropped upon a rubber conveying belt and is discharged into

a revolving drum dryer known as air-heated dryer in which the moisture is reduced from 2 per cent to less than $\frac{1}{4}$ of 1 per cent.

The normal specifications of sulphate of ammonia, calls for a sulphate of ammonia containing not under 25 per cent NH_3 . This would enable us to have a moisture content not to exceed 2 per cent. However, a considerable demand is being made for a very dry sulphate, in which the moisture content is reduced to less than .15 per cent water and the acid content under .15 per cent. In order to secure these results the air-heated dryer drum has been introduced and this high grade quality procured.

Practically all the sulphate of ammonia is used as a fertilizer—in some cases blended with bone dust and in many cases used without mixing with bone dust or phosphates. From the analyses of the coal it will be noted that it contains approximately 5 per cent of combined water and 3 per cent of free water, making a total of 8 per cent of water. This water is condensed and dissolves out of the gas and the tar a certain amount of ammonium sulphide and ammonium carbonate and practically all of the chloride of ammonia. Thus the ammonia which is taken out of the gas by this water amounts to approximately 20 per cent of the total ammonia content of the gas.

This weak liquor, as it is called, contains about 1 per cent of total NH_3 , is separated from the tar by gravity, in separating tanks, and is put through ammonia stills where it is brought in intimate contact with a solution of lime water and steam. The lime combines with the ammonium chloride forms calcium chloride and the ammonia is driven off as a gas and is led through cast iron pipes into the gas mains before the saturators, thus, all being converted into sulphate of ammonia. If, however, there is a market for concentrated ammonia liquor, the ammonia gases from the ammonia stills, instead of being conducted to the saturators are condensed into liquor and sold as ammonia liquor containing 20 per cent to 25 per cent NH_3 .

The tar, after it has been allowed to settle and the ammonia liquor separated, (which takes place by gravity), is then loaded into tank cars of 10,000 gallon capacity, most of which is shipped to the open hearth and heating furnaces where it is burned in connection with coke oven gas as a fuel for the production of open hearth steel and the remainder is disposed of to various tar using industries.

The following is a typical analyses of Clairton coal tar:

Moisture	1.25 %	
Specific gravity	1.156 (at 15° C.)	
Viscosity	140 at 60° (Saybolt Method)	
Free carbon	4.25 %	
Btu per pound.....	16,200	
Sulphur	.55 %	
Distillation		
Light oil (0° to 170° C.).....	.20 %	
Carbolic oil (170-230° C.)	9.60 %	} 3% Carbolic Acid 6% Cresylic Acid
Creosote oil (230-270° C.).....	10.20 %	
Anthracene oil (270-350° C.)...	23.00 %	
Pitch (at 350° C.)	57.00 %	
Coke residue at 1200° C.....	17.20 %	

After the gas passes the ammonia saturators, it is passed through final coolers where it is brought in

direct contact with a water spray and cooled from 60 degrees C. to 25 degrees C., at which temperature it is passed through the oil scrubbers.

These oil scrubbers, arranged three in a series, are 16' 0" in diameter and 100' 0" high, filled up with wooden grids for 80' 0" in such a manner that the oil which is trickling down through the grids from a series of 24 sprays at the top comes into intimate contact with the gas. The wash oil, as it is called, absorbs the benzol vapors from the gas. These oil scrubbers are so designed that the gas will have a speed of not under three feet per second and a time of contact through these series of three scrubbers of not less than 60 seconds. In this manner 96 per cent of all the benzol vapors are extracted from the gas at a temperature of 25 degrees C. and the oil will have a saturation of $2\frac{1}{2}$ to 3 per cent of benzol and its homologues.

The gas, after it has been debenzolized, is metered by a Thomas meter, i.e., an electric meter which measures the current required to heat up the gas 2 degrees C., after which it is passed to a 100,000 cubic foot regulating holder. Forty-three per cent of this gas is required for heating up the ovens, while 57 per cent is known as surplus gas and is sent to the booster station where it is boosted by steam driven turbines to a pressure of seven pounds and delivered through a 40-inch gas main for a distance of six to nine miles, supplying gas to the steel mills at Clairton, Duquesne, Homestead and Braddock. The following is a typical analyses of Clairton debenzolized (fuel) gas:

Carbon Dioxide (CO ₂)	1.8 %	By volume
Carbon monoxide (CO)	3.5 %	By volume
Illuminants C ₂ H ₄	3.0 %	By volume
Methane (CH ₄)	34.6 %	By volume
Hydrogen (CH ₄)	53.9 %	By volume
Nitrogen (N ₂)	3.2 %	By volume
Btu's calculated	582.9	
Hydrogen sulphide as sulphur, lbs. per 1,000 cu. ft.	.75 lb.	

The wash oil, thus saturated with benzol and its homologues to the extent of $2\frac{1}{2}$ to 3 per cent, is pumped to the wash oil stills at the benzol plant, where it is heated up to a temperature of 150 degrees C. through superheaters, then led into the wash oil stills where it is brought into contact with live steam where the benzol vapors are driven out of the wash oil. These are condensed and separated from the water and form what is known as light oil. The wash oil, thus debenzolized to a point where it contains less than .3 per cent light oil, is cooled off through pipe coolers and returned on its journey to take up another load of benzol.

The light oils coming from the light oil stills, contain approximately 8 per cent of wash oil and naphthalene. This wash oil and naphthalene is removed by distilling the light oils in an intermittent still known as a crude still (capacity 20,000 gallons), thus, approximately 92 per cent of the benzol and its homologues are distilled off, leaving a residue of naphthalene and wash oil. This residue is drawn into a decanter tank and forced by air pressure into cooling pans where the naphthalene is crystallized out and the wash oil is returned to the circulating system.

The light oil analyses approximately as follows:

Crude benzol	63%
Crude toluol	16%
Crude No. 1 solvent	8%
Crude No. 2 solvent	5%
Wash Oil and Naphthalene residue	8%

In this crude distillation the total benzol fractions with the exception of the heavy No. 2 solvent are combined, while the heavy solvent is separated. The combined benzol fractions are then pumped into a lead lined agitator which is capable of holding 10,000 gallons of crude benzol. Then .4 pounds of 66 degrees sulphuric acid per gallon of product is added (acid being added in small quantities) and the content is agitated for a period of three hours, after which the sludge, which consists mainly of thiophenes and unsaturated hydrocarbon compounds, is removed and drawn off into an acid pot. After the benzol is sufficiently washed with acid, which is determined by laboratory tests, it is then washed with water and neutralized with a 10 per cent solution of caustic soda. The water and the caustic soda are drawn off and this washed benzol product is then pumped to the pure stills where the product is either fractionated into pure products or refined into mixed products, according to the market requirements. The loss sustained in washing amount to 9 per cent of the product washed, while the loss sustained in the pure stills amounts to 8 per cent of the product in residue and non-condensable gases.

The remainder of this paper, describing the equipment for the coke plant, will appear in the July issue of the BLTAS FURNACE AND STEEL PLANT. The following is a description of supplementary development in connection with Clairton by-product coke works:

Five hundred modern dwelling houses, four to nine rooms each, each equipped with furnace, running water, gas, electric light and bath. Five boarding houses for accommodating a total of 128 men. Fifty three-room houses for colored families, each equipped with running water, gas, electric light and toilet. One community laundry and bathhouse for colored families. One complete sewage disposal plant in connection with house in Wilson townsite. One 40-inch diameter gas line, $8\frac{1}{2}$ miles long, delivering gas to Duquesne, Edgar Thompson and Homestead, and one 30-inch diameter gas line 6,000 feet long delivering gas to Clairton Steel Works and Furnaces. One standard gauge railroad, 8 miles long, connecting Clairton to Duquesne. Five hundred 100,000 pounds capacity steel hopper cars for coke shipments. One river transportation fleet consisting of the following craft: One hundred and twenty steel barges, 27' 0" wide, 175' 0" long, having a capacity of 1,000 tons of coal, 9' 0" draft. Seven towboats, six of the stern wheel type and one of the screw propeller type, each boat capable of handling six loaded barges to the tow. One gasoline tug for spotting barges in front of hoist and assembling empties. One bulldozer, and one ice breaker.

The July issue of the BLAST FURNACE AND STEEL PLANT will contain that part of Mr. Marquard's paper dealing with an itemized account of the equipment which constitutes the plant of the Clairton by-product coke ovens.

Electric Soaking Pits and Furnaces

Higher Fuel Cost Offset by Labor Saving, Precision of Treatment Produced and Elimination of the Rejection of Parts Due to Defective Heat Treatment.

By T. F. Bailey,

President the Electric Furnace Company, Alliance, O.

The introduction of electrically heated furnaces to the heating operations subsequent to melting and refining in the steel industry has experienced the slow development incident to the introduction of all radical innovations in any industry. Many of the types that will find wide application in the future, while entirely feasible, have, when offered, been met with the statement that if such an equipment was a good thing, why were they not in general use. Other types, that have been in regular service for a considerable number of years, whose construction and operation are much more elaborate and whose commercial advantages are no greater, are now generally accepted as the most rugged and reliable equipment for the purpose. This latter refers to electric furnaces for the annealing and heat treatment of steel.

One of these types installed some three years ago, and described more than two years ago in a paper before this institute, has been used exclusively since its installation for the particular material for which it was designed—namely, cast steel draw bar knuckles—and subsequent to the installation of the first unit, a second unit of the same capacity was installed. This equipment has, since its installation, handled over 50,000 tons of material, approximately half of all the material of this character used on American railroads having passed through these furnaces.

The higher "fuel" cost for electric furnace over fuel fired furnaces that might have been used for the same purpose, has been amply justified in commercial practice by the labor saving effected, the precision of the treatment produced, and the elimination of the rejections of parts due to defective heat treatment; the precision of the laboratory being obtained in regular plant practice.

There has been a reluctance of manufacturers generally to consider that there is a difference in cost per ton of material put through a furnace and the cost per ton of material heat treated and coming within the specifications. There has been no greater factor in changing this attitude than the conditions brought about during the war, where in a great many plants there was a wide difference between the quantity of material inspected and the quantity of material accepted. Manufacturers now are generally conceding the justness of the higher requirements of steel, and this is one of the greatest arguments in favor of electric furnaces.

Three conspicuous examples of the electric furnace for heat-treating are those for Liberty Motor crank shafts, over half of which were so heat-treated; cast

steel anchor chain, all of which was heat treated in furnaces of this character; and draw bar knuckles, substantially half of those which are used in America being thus heat-treated.

These examples are typical of the furnaces to be described in this paper adapted to other operations in the steel industry, and embrace soaking pits for the soaking of hot stripped ingots, re-heating furnaces for hot blooms and billets, combination fuel and electric furnaces for the heating of cold bloom and billets, recuperative car type annealing furnaces for bars and sheets, and automatic heat-treating equipments for drop forgings and castings and for the heat treatment of steel rails and similar material.

The Electric Soaking Pit.

The electric soaking pit for hot ingots is perhaps the most promising development of the electric furnace to the steel maker, as the shortcomings of the present pits, whether of the fired or non-fired type, are well known, and many troubles of the rolling mill can be traced to the present type of pit.

The principal recommendation of the present type of pits, either of the fired or non-fired type, is the low fuel consumption per ton of metal soaked. This cost in a well handled pit is almost a negligible item, amounting frequently to only a few cents a ton.

However, in the larger mills, when running at full capacity, features such as lack of uniformity in temperature of the heated ingot, excessive oxidation of the ingot, and the like, are often such as to quite outweigh the item of mere fuel cost; and while it is to be admitted that electric pits cannot compete with fuel fired pits under ordinary circumstances, when heating cold ingots, the time is not far distant when substantially all modern mills rolling ingots will use electric pits for this part of steel mill operation.

It has been difficult to overcome the prejudices against this innovation in ingot soaking; but the advantages to be gained are so apparent, and the success of electric furnaces in other similar fields has been so marked, that it will not be long until electric soaking pits will be in commercial operation.

From electric furnaces operating at the same temperature, or at even higher temperatures than that required in soaking pits, and which have been operating over long periods of time, it is apparent that the standby, or wall losses, of a typical pit adapted to hold 16 three-ton ingots will not exceed, as a maximum, 1,000 kw, and will be expected to operate on considerably less current.

However, taking 1,000 kw as a basis, which is amply safe, and when operating on hot ingots, whose

From paper read before May meeting of American Iron and Steel Institute.

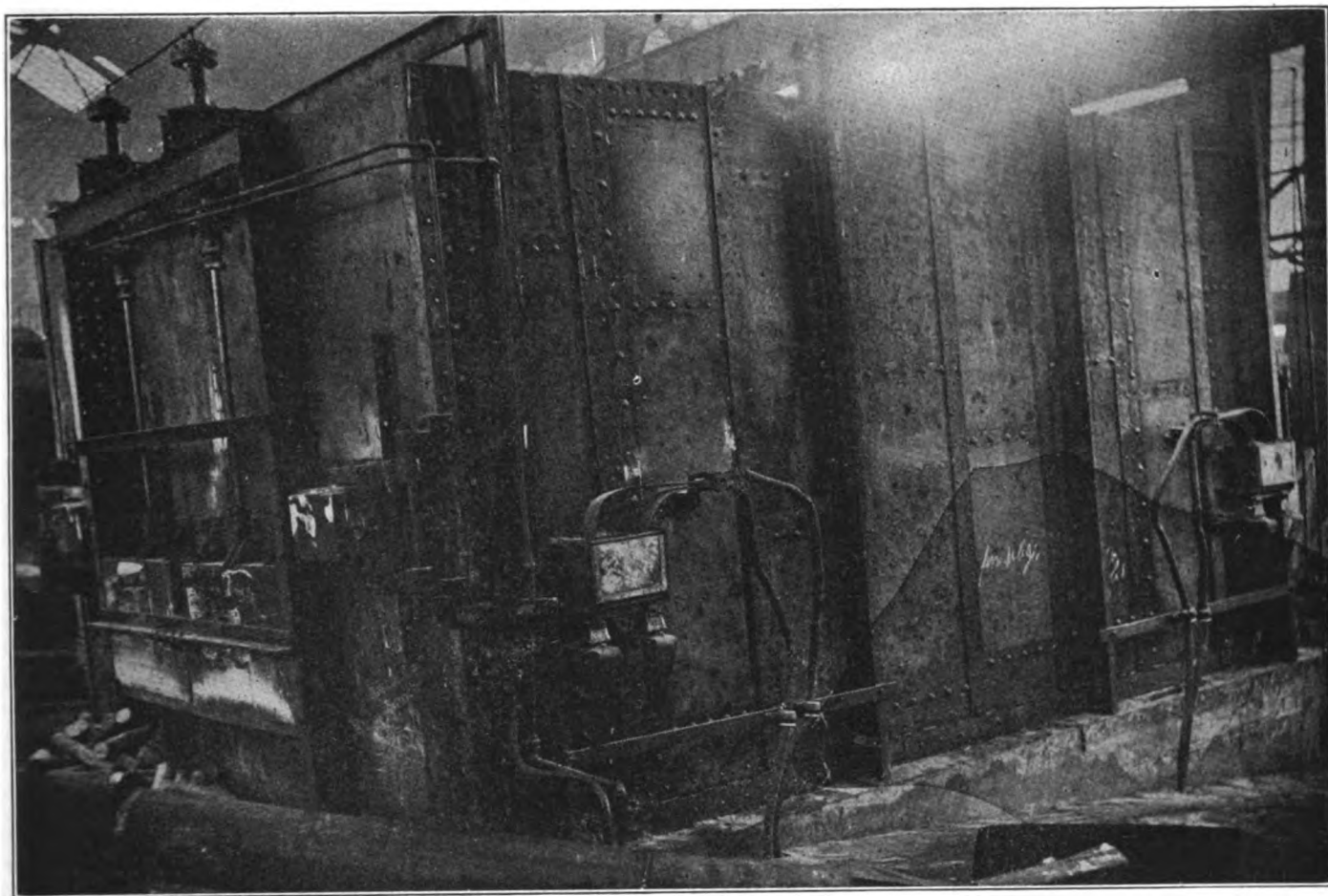


Fig. 1—Electric billet heating furnace.

superheated interiors are sufficient to bring to temperature their colder outer shells; and operating on a soaking time of one and one-half hours, the capacity per pit will be 32 tons per hour, and with a figure of 1,000 kw per hour for the furnace, the current consumption per ton of metal soaked would thus be 35 kwh per ton; and taking as a basis of cost of electricity in the steel mill of $\frac{1}{2}$ cent per kilowatt, the cost per ton of metal soaked would be $17\frac{1}{2}$ c, to which might be added a cost of 5c per ton for renewals and repairs, making a total cost of $22\frac{1}{2}$ c per ton for these two items.

It is to be expected that this cost for heat may be in excess of similar costs for gas fired pits or unheated pits; but when taking into consideration that the electric pit will eliminate the roll breakages due to cold ingots; delays in the mill due to ingots unevenly heated; oxidation, thus producing a cleaner bloom and an actual saving in metal due to this elimination of oxidation, amounting to perhaps one-half of 1 per cent; as well as the ability of the electric pit to save labor; it is certain that the higher cost will be more than offset by the advantages, and that per ton of metal rolled in a given period, the actual cost by the use of an electric pit will be less than by other means.

The general arrangement and character of such a pit is briefly described, as follows. The pit will be provided with eight holes, instead of the usual four, and in consequence only half as many ingots will be located in each cell.

The resistance elements themselves, composed, as in all furnaces of this class, of broken carbon thrown loosely into a carborundum fire sand trough supported on brick pillars, are located along the outer wall of each side of the pit, and protected against the liability of serious accident from the ingot being recessed some distance back from the ingot cell itself. The heat from this resistance element, it will be noted, is radiated to the circular wall of the pit, and thence to the cover, the partition wall of the pit, and to the ingots themselves. The cross section of this resistor element is such that there is very little difference between its temperature and the ruling temperature of the pit; and in actual practice most of the heating is done by the walls of the pit itself, rather than by direct radiation from the resistor element—this being of the highest importance in obtaining uniformity of heating.

In cases where the ingots cannot be delivered to the pit with enough heat for them to reach a high enough temperature without the addition of more heat from the pit itself; a longer time will be required by the ingots to bring them to temperature, and at the same time the capacity of the pit in tons per hour will be reduced.

But taking as a basis, ingots whose average temperature would be 1,800 degrees F., requiring 300 degrees additional for bringing them to temperature, the capacity of the pit would be reduced to 24 tons per hour, the electrical capacity of the pit increased to

1,500 kw, and the current consumption increased to 60 kwh per ton.

While with ingots charged at an average temperature of 1,500 degrees F., the capacity of the pit would be reduced to 16 tons per hour, and the current consumption increased to 90 kwh, without increasing the electrical capacity beyond 1,500 kw.

Thus we have for a total of heating costs, including the renewals and repairs, and with power taken at $\frac{1}{2}$ ¢ per kw

For hot ingots.....	22½¢ per ton
For ingots @ 1,800° F.....	35 ¢ per ton
For ingots @ 1,500° F.....	50 ¢ per ton

the final temperature in each case being taken as 2,100 degrees F.

These figures can be safely taken as guarantees, and it can be expected that they will be much bettered in actual practice and operation over long periods of time.

Continuous Type Re-Heating Furnaces.

It is believed that this type of furnace will find wide application in the heating of cold steel for forging and rolling in relatively small capacities, and in re-heating steel of high quality; but where very large tonnages of cold blooms or billets are to be heated, a combination fuel and electric furnace—to be later described—will be better adaptable for such work.

Figure 1 illustrates an all electric billet heating furnace.

This furnace was built for heating $3\frac{1}{4}$ inch round billets for shell forgings, and while the current cost for supplying this particular furnace was high, and the operating conditions not particularly favorable; nevertheless, the reduction of rejections of forgings due to eccentricity, the saving of the dies due to the elimination of scale, and other advantages, such as better working conditions and simplicity of control, enabled the results to compare favorably with coal fired practice.

This furnace was of 600 kw capacity, and in actual practice handled $1\frac{1}{2}$ tons of steel per hour, with a current consumption of a little over 450 kwh per ton, or a thermal efficiency of a little more than 50 per cent. Under more favorable conditions, an efficiency of 60 per cent, or a current consumption of approximately 300 kwh per ton has been obtained. So that with low cost of current, which it is believed may be taken as $\frac{1}{2}$ ¢ per kilowatt in steel mill power costs, the fuel cost for cold heating in units of this size would be \$1.50 per ton.

This cost will compare favorably with direct coal fired furnaces of similar capacity, and will actually show some commercial advantage, when taking into consideration the saving in metal due to scaling, which may readily run several per cent, and at least in average operating conditions may be taken as 2 per cent, and under the worst conditions 5 per cent, which has been actually observed in one or two instances.

Furnaces of larger capacity than the one described, of course, show a less favorable comparison to the electric, and furnaces of smaller capacity show a more advantageous comparison with the electric furnace;

and it is believed that in any case, the cost of material heated in furnaces of this size, all things considered, may be safely taken as running close together, with the electric furnace having the advantage in greater uniformity of temperature and other incidental advantages, including a higher yield of good finished pieces.

An application that it is believed will find favor in certain steel mill operations is the use of an electric furnace for reheating billets for finishing mills, wherein the blooms or billets coming from one mill are too cold to put into the finishing mill and will require approximately 200 degrees additional heat.

The calculations on such an equipment are based on a capacity of 15 tons of 4-inch square billets per hour, charged into the furnace at 1,800 degrees F., and brought to 2,000 degrees F. Such a furnace would require 800 kw per hour for its operation, and somewhat under 60 kwh per ton of metal re-heated, and with $\frac{1}{2}$ ¢ for power, this would make a cost of 30¢ per ton of metal thus re-heated. As an electric furnace of this character would undoubtedly save one-fourth of 1 per cent of metal over fuel fired furnaces, which would amount on steel worth \$40 per ton, to a saving of 10¢ per ton, and when taking into consideration the low efficiency to be expected of a fuel fired furnace of this character operating on hot billets only, there would be a decided advantage in the use of the electric furnace for such an operation.

Combination Fuel and Electric Re-Heating Furnaces.

Where large tonnages of cold blooms and billets are to be heated, however, unless electricity can be obtained at an exceptionally low rate, and fuel can only be had at a high cost, a combination gas and electric furnace, wherein the earlier stages of the heating up to say 1,800 degrees F. is handled by fuel, and the final temperature handled electrically, is perhaps the only type that can compete with the continuous fuel fired billet heating furnace.

Such a combination would enable the preliminary heating to be done with fuel, without danger of excessive oxidation that is present in the fuel fired billet heating furnace, and will insure a uniformity in the heating of the billets that is not generally obtainable in fuel fired furnaces of this type; and while there would be a small saving of perhaps 50 pounds of coal per ton of metal heated, due to the lower temperature to which the billets are heated by the fuel fired end, against this must be charged say 60 kwh per ton of metal, or 30¢ per ton of metal heated for the final stage by electricity; nevertheless, the advantage of uniformity in temperature, elimination of scale, etc., and more accurate control, will justify in many cases the use of such a combination furnace.

Annealing Furnaces.

Of the annealing furnaces in the steel industry, the recuperative car type will have perhaps the widest application. Two furnaces of this type are now under construction. The largest of these will have a capacity of 150 tons per day when annealing at 1,200 degrees F., and is adapted for the annealing of cold rolled strip and sheets. The second furnace, though having ap-

proximately the same dimensions, will be for annealing alloy steel bars, which require a long soaking time at maximum temperature.

One notable feature of these furnaces is that the annealing will be done without the usual covers required in fuel fired furnaces ordinarily used for this work, which will constitute one of the greatest savings in annealing, as compared with present methods. This recuperative type furnace lends itself to the highest economy, as after the steel has reached the full temperature and is passing toward the discharge end of the furnace, a large part of this heat is given up to the cold incoming material.

One interesting installation may be cited which is of 600 kw electrical capacity, and is approximately 225 feet long by 22 feet wide. The material is handled on sand sealed cars, each car being substantially 13 feet long by 4 feet wide, and adapted to hold 20 tons of material, there being in all 17 cars located on each of the two lines of track passing through the furnace, each line of cars passing in opposite directions. In the middle of the furnace is located the heating chamber proper, which is 26 feet long, holding two cars in the heating on each track at a time, or substantially 80 tons of material at a time in the heating chamber.

A movement of the cars takes place on each track approximately every six hours, discharging at that time two 20-ton cars of material, one at each end of the furnace, and similarly charging at each end of the furnace a car of cold material. The cars are moved forward by means of a hydraulic pulling machine, operated by a 600 pound water pressure system.

One of the requirements of this equipment is that when annealing low carbon cold rolled strip, the hardness should not exceed 20 scleroscope measurement. All of the tests taken were between 18 and 19.

While no tests for maximum capacity could be taken at the time, owing to sufficient steel not being available, the operation at half capacity was well within 200 kwh per ton, which clearly indicated that when operating at full capacity the current consumption would be somewhat under 120 kwh per ton.

Taking again large steel mill practice of current at $\frac{1}{2}$ c per kilowatt, the cost of annealing in this type of furnace would not exceed 60c per ton, which will compare favorably with coal fired annealing furnaces from a fuel standpoint, and in addition will completely eliminate the expense of covers, as well as a considerable amount of labor and will introduce a precision in annealing which it is not possible to obtain with present equipment.

Another equipment of this character, although of approximately the same dimensions, excepting being somewhat shorter in length, requires a larger heating chamber proper, even though the rated capacity is only 75 tons per day. This is due to fact that the metallurgical requirements are such on the alloy steel to be treated that the material must be soaked for 40 hours at a maximum temperature of 1,400 degrees F.

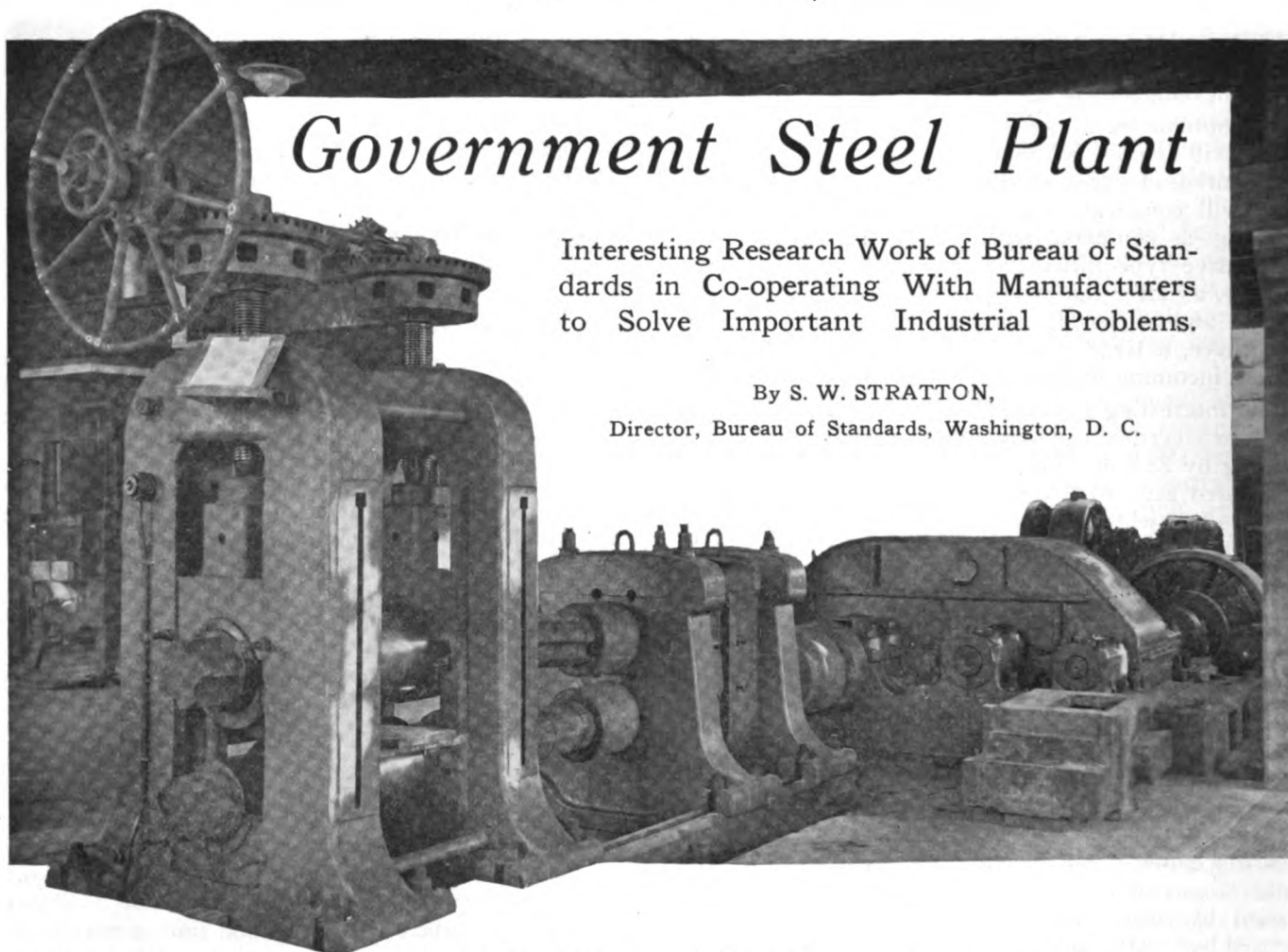
The furnace itself is supplied with 800 kw transformer capacity, and will operate with a current con-

sumption something under 250 kwh per ton of metal annealed. In this furnace ten 15-foot cars, each holding 30 tons of material, are located on each of the two tracks; and a maximum of 600 tons of material is in the furnace at a time, 120 tons of which are in the heating zone proper. The full movement of each line of cars will take place substantially every 20 hours, delivering substantially 72 tons per day.

One of the special requirements of this furnace is that the cooling from maximum temperature over the first 200 degrees of the cooling range must not take place at a greater rapidity than 10 degrees per hour. This necessitates the introduction of a very powerful and slow mechanism, wherein the speed of travel does not exceed nine inches per hour.

This special equipment consists of a motor operated chain haul, similar to the equipment used in the larger types of draw benches for tube drawing, and is supplied with a 10 hp motor through seven gear reductions. As the cars must pass through a sealed entrance hood or chamber before going into the furnace proper, this precaution being found necessary in order to prevent reducing the atmosphere of the furnace during charging, the pushing mechanism and the door operating mechanism are interlocked, so that when the push button starter is operated, the interlocked mechanism first raises the door of the entrance hood, then the cold car of material is pushed into the chamber, the entrance door closed, the door to the main furnace next opened, the pusher continuing the push of the car just far enough into the entrance hood until it comes in contact with the main line of cars in the furnace. From this point on, the travel is at the rate previously mentioned, namely nine inches per hour, during which time the door at the discharge end of the same line of cars at the opposite end of the furnace is opened, and the car at the discharge end moved into the cooling hood at that end, the discharge door on the vestibule itself still being closed. When the cold car being pulled in has come fully within the door line of the furnace proper, the door is dropped behind it and the heating chamber thus sealed.

At this point, the pushing dog behind the car is reversed and it is returned to its starting position to bring another car into the entrance hood. While doing so however, a pull out chain, operated by the same shaft as the main pulling drum, latches, through means of a special dog, into the car of cooled material on the opposite track, moving it a few inches forward from the line of cars that has pushed it to the discharge position, then the interlocking mechanism drops the door in front of the line of cars, after which the outer door of the vestibule is opened, and the drawback mechanism pulls the car entirely clear of the furnace, at which time the door of the vestibule is closed. Immediately following this operation, a similar operation to the one just described begins at the opposite end of the furnace, the chamber and the furnace proper being first opened. The remainder of the author's paper describing anchor chain heat treating furnaces, will appear in a later issue of the BLAST FURNACE AND STEEL PLANT.



Government Steel Plant

Interesting Research Work of Bureau of Standards in Co-operating With Manufacturers to Solve Important Industrial Problems.

By S. W. STRATTON,
Director, Bureau of Standards, Washington, D. C.

S. W. Stratton, director of the Bureau of Standards, Washington, D. C., read a very interesting paper before the fifteenth general meeting of the American Iron and Steel Institute concerning the work of the Bureau of Standards as related to industrial problems. Particular emphasis was given to the great possibilities of the bureau in coöperating with manufacturers to solve industrial problems. Referring particularly to the steel industry Mr. Stratton suggested that the American Iron and Steel Institute appoint a technical committee to visit the bureau and take up problems of interest to the iron and steel industry.

Mr. Stratton described and illustrated examples of the work that the Bureau of Standards had done during the war acting as a medium between the manufacturer and the government for the purpose of determining standards and specifications. A particularly interesting development during the war was the adoption of the end standards and the abandoning of line standards for the accurate determination of length.

Length Standards.

Figure 1 shows a box containing 34 Hohe precision gauges manufactured at the Bureau of Standards, all of which are accurate in length and flatness to five millionths of an inch.

The gauges are arranged in five series as follows:

First series	3 gauges differing by .00025 inch
Second series	9 gauges differing by .001 inch
Third series	9 gauges differing by .010 inch
Fourth series	9 gauges differing by .100 inch
Fifth series	4 gauges differing by 1.000 inch

By suitable combinations of those gauges combinations can be secured to give any desired dimensions between 10 inch and .200 inch, in steps of one quarter thousandth of an inch. The accuracy of the faces makes it possible to "wring" the blocks together so that the three or four blocks, that may be required for a particular dimension, can be handled as one block. Experiment has shown that blocks carefully "wring" together require a force as great as 30 pounds per square inch of their contact surfaces to separate them. The United States Bureau of Standards tested thousands of manufacturers' gauges during the war.

Government Test of Railroad Track Scales.

On account of the tremendous amount of revenue collected from the weights taken on railroad track scales, the government has a particular interest in their accuracy; however, before the government took charge of the railroads, it was looking after the interest of the public by means of the railroad track scale testing equipment which had been operated by the Bureau of Standards. The nature of this equipment is shown in Fig. 2.

This equipment is designed to be the most accurate of its kind in the world. It is housed in a freight car. Its character can be understood from its method of use. In testing a scale, the car is placed a short distance from the end of the scale, and the end doors of the car are opened. A gasoline engine driven electrical generator is then started which furnishes the

required power for operating the apparatus. Overhead crane rails are next advanced from the end of the car and overhang the track between the car and the scale.



Fig. 1—Hohe precision gauges
Manufactured at the Bureau of Standards.

A standard gauge electrically driven truck is then deposited on the tracks by means of the crane. This truck is adjusted to have a weight of exactly 5,000 pounds.

In the ordinary test, 10,000 lb. cast iron weights and other smaller weights are then added to the truck until the test load is 40,000 pounds. The truck is then moved from point to point on the scale and the indication of the scale taken and compared with the known load of the truck. After this has been furnished for each position of the truck used, it is returned to the sets in front of the test car and other weights added until the truck and load weigh exactly 80,000 pounds. The test is then made as before. For other occasions as for master scales and special tests other test rails can be secured and the scale can be tested to any degree of detail desired. With this equipment using the accurately standardized cast iron weights used in the car and protected from weather and abrasion, it would be possible to ship the car around the world and yet be sure of the value of the weights.



Fig. 2—Car for testing railroad track scales.

Thermometer Testing.

Considerable amount of investigation has been conducted and tests made regarding accuracy of ther-

mometers. Figure 3 shows a comparator for testing thermometers used to measure temperatures in the arrangement of 100 degrees C. to 320 degrees C. The thermometers, both test and standard, are immersed in a bath of oil which is heated by electricity to the desired temperature. The oil is stirred rapidly by a propeller in the lower part of the bath attached to the pulley shown. This pulley is turned by the electric motor acting through the belt. The hood shown above the belt carries away the fumes from the heated oil. A holder of thermometers and standard thermometers is shown. The standard thermometers and the heat thermometers are read at the same time by means of the telescope. As all of the thermometers are at the same temperature and the exact temperature of the bath is known from the standard thermometers,

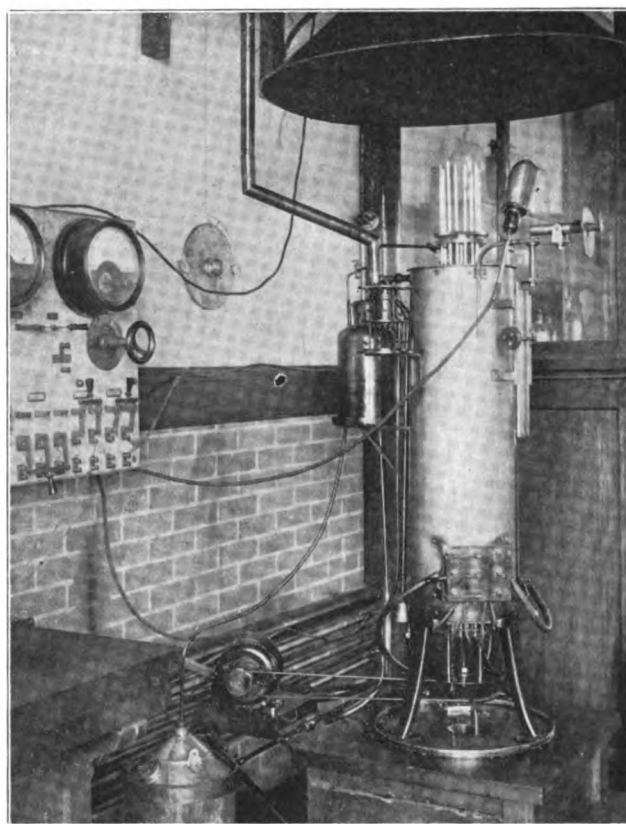


Fig. 3—Comparator for testing thermometers.

the error, if any, of the heat thermometers can be detected.

Description of Rolling Mill.

The rolling mill installed in the Division of Metallurgy (shown on the headline of this article). Bureau of Standards, was manufactured by the Philadelphia Roll & Machine Co., of Philadelphia, according to specifications of the bureau. As the mill is used entirely for special work in connection with investigations of the properties of metals, operating speed leading to quantity production has been somewhat sacrificed in order to secure flexibility and adaptation to all requirements.

The rolls are arranged "two high" and in the present equipment are 16 inch diameter and 24 inch long. The roll housings can, however, be extended to accommo-

date 50 inch rolls. The maximum opening of the rolls is 4 inches. Two sets of plain cast iron rolls are provided, one sand cast for hot work and the others chill cast for cold rolling. With these two sets of rolls any ferrous or non-ferrous metal may be rolled into sheets, plates, or rectangular sections by either hot or cold work. It is hoped in the near future to secure a pair of 50 inch grooved rolls for rolling round bars or rods.

The drive is by means of a 150 hp General Electric motor, having a speed variation from 250 to 1,000 rpm. This is connected to the mill by a flexible coupling to double reduction herringbone gears running in oil. Final drive to the rolls is accomplished by means of manganese steel pinions and the necessary "breaking pieces" and "wobblers." The rolls can be run at 20 rpm to 80 rpm.

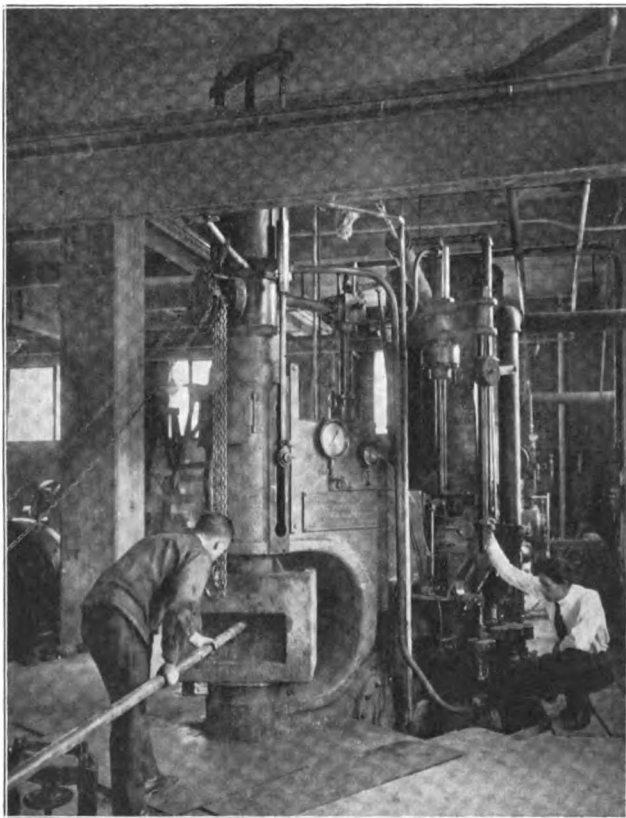


Fig. 4—150-ton steam hydraulic forging press in laboratory of Bureau of Standards.

The principal use of the mill so far has been in a study of zirconium steel armor plate. Ingots $3\frac{3}{4}$ inch diameter and weighing up to 30 pounds have been rolled into plates $\frac{1}{2}$ and $\frac{3}{8}$ inch thick and about 16 inches wide. These ingots have all been manipulated by hand but considerably larger ingots can be handled by the use of an overhead trolley or a mechanical rolling table. In either case it is necessary to lift the ingots back to the entering side since the mill is not reversible.

Forging Press.

The press shown in Figure 4 is a 150-ton steam hydraulic forging press. The photograph shows

this press fitted with shears and shearing 2-inch cold rolled shafting. This shearing attachment can be dismounted and forging dies placed in the press in about 30 minutes. In this equipment, air at 100 pounds pressure is used in place of steam for operating the press. The air is supplied to the press from a 150 hp compressor through a 250 cu. ft. receiver. The movements of the press are controlled by a single lever, the movement of the press lead follows that of the controlling lever, both in speed and length of stroke. The press can operate at 100 to 150 strokes per minute and can exert a pressure between dies of 150 tons. The pressure stroke of the press is about $3\frac{1}{2}$ inches.

Mr. Stratton described very thoroughly numerous other phases of the work being done by the Bureau of Standards referring particularly to the testing of the Liberty engine. Tests were made in which the engine was subjected to similar temperature and atmospheric conditions as would exist in altitudes of 20,000 to 30,000 feet. The air in the testing room was exhausted and refrigerated to suit atmospheric and temperature conditions for such altitudes. An interesting explanation was given explaining how enemy batteries were located by the record of sound waves. The testing of brick columns subjected to high temperature was explained as well as the delicate processes in the manufacture of optical glass.

Mr. Stratton pointed out particularly that it was the desire of the bureau to serve and to work hand in hand with American manufacturers in solving difficult industrial problems. His review of the numerous problems which the bureau investigated during the war, and the value of these investigations gave sufficient evidence of the service which the bureau has to offer. As an example of saving in cost of manufacture he explained the very interesting method of casting refractory crucibles from kaolin. These crucibles are now made, following the method developed by the bureau, at a cost of \$9 each, when they had previously cost \$55.

The illustrated informal talk also brought out how proper specifications had been developed by means of cement mill erected at the bureau. Referring again to the detection of enemy batteries by sound waves, the speaker exhibited a chart which he termed as being a record of the end of the war. The chart was made by a delicate sound recording instrument, and recorded the earth vibrations caused by heavy artillery action. Several hours before 11 o'clock on the morning of November 11, 1918, were recorded as well as several hours after this time. The change in vibrations was very perceptible. Thus a record of the end of the war was made by this instrument.

The building work done by the bureau was described in the March, 1919, issue of the BLAST FURNACE AND STEEL PLANT.



ANNOUNCEMENT

of

STEEL MILL STEAM POWER
DEPARTMENT

The following pages represents the inauguration of a new editorial department which THE BLAST FURNACE AND STEEL PLANT will maintain regularly in each issue. The fact that the steel industry develops more than twenty-five per cent of the total steam engine and turbine horse power developed in this country in manufacturing industries, together with the ever-increasing necessity for economical steam production and consumption has been the prime factor in our decision to establish this department. The editorial content of this department will consider primarily those specialized problems which are distinctive to the steel industry, such as the following subjects: Steam Engine Drives for Rolling Mills; Blast Furnace Gas and By-Product Coke Oven Gas for Boilers; Combined Blast Furnace Gas and Stoker Fired Boilers; Pre-Heating Air for Blast Furnace Gas Fired Boilers; Types of Burners for Burning Blast Furnace Gas; Descriptions of Typical Modern Steam Power Plants in Steel Plants; Turbines in Steel Mills, Turbo Blowers for Blast Furnaces; Waste Heat Boilers for Open Hearth; Uniflow Engines for Mill Drives, and Powdered Coal for Boilers.

ARTICLES IN THIS ISSUE:

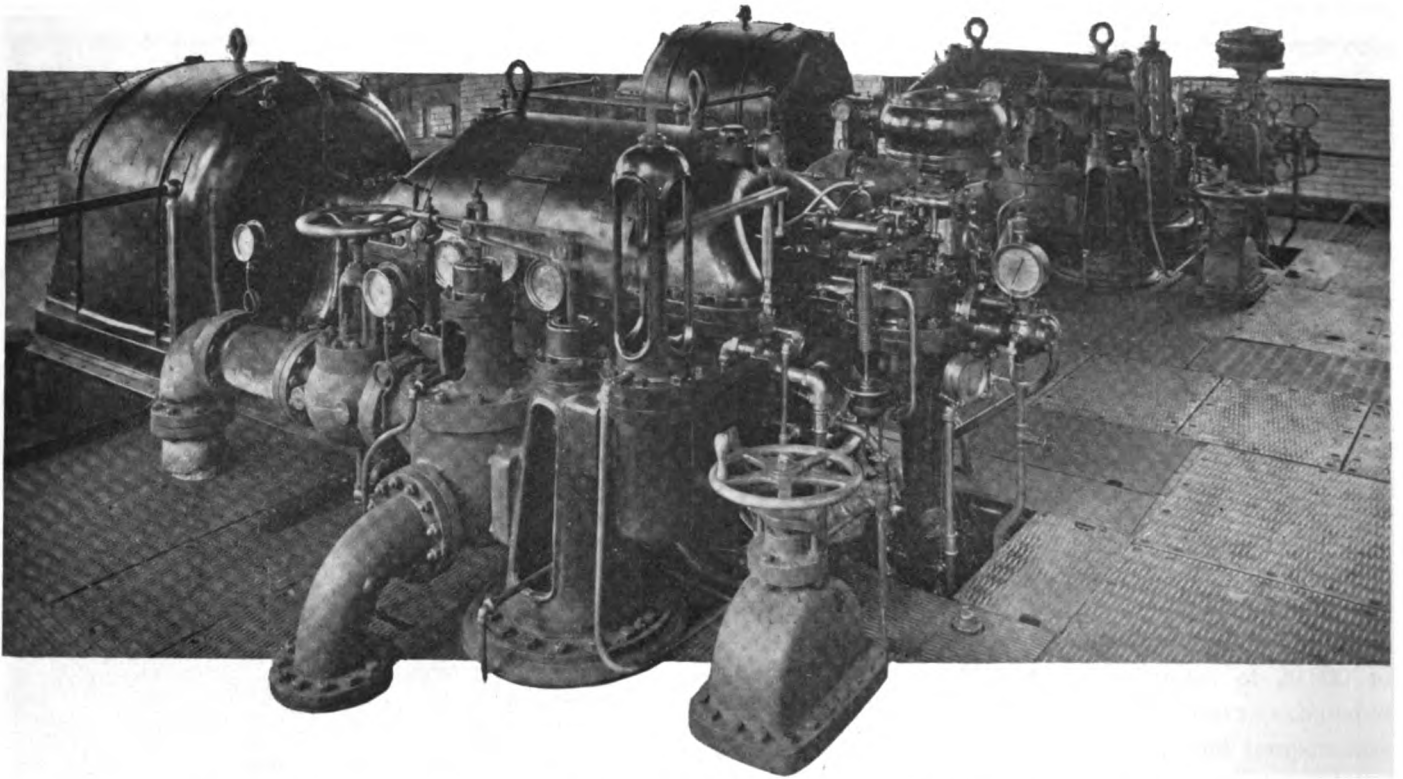
How Do You Utilize Your Exhaust Steam?
BY D. O. TYLER.

Combustion Control in Mill Boiler Plant
BY ROBERT JUNE.

Economical Fuel Burning Equipment
BY J. G. WORKER.

Suggestions for Correct Boiler Baffling
BY A. D. WILLIAMS.

Unique Pump House for Blast Furnace.



How do You Utilize Your Exhaust Steam?

Plant Capacity Almost Doubled by Utilizing Heat in Exhaust Steam by Means of Steam Turbine Designed to Operate on Exhaust or Low Pressure Steam.

By D. O. TYLEE,

Turbine Section Power Dept., Westinghouse Electric and Manufacturing Company.

In almost all of the older steel plants where steam drives are still used there is a considerable waste of steam which could be turned to profit.

At the plant of one of the large steel concerns a large quantity of exhaust steam from hydraulic pumps, air

compressors, exciter units, steam operated bloom shears, reversing mill engines and Corliss engine generator units was for the most part blown away to the atmosphere.

The proposition that confronted this concern was to

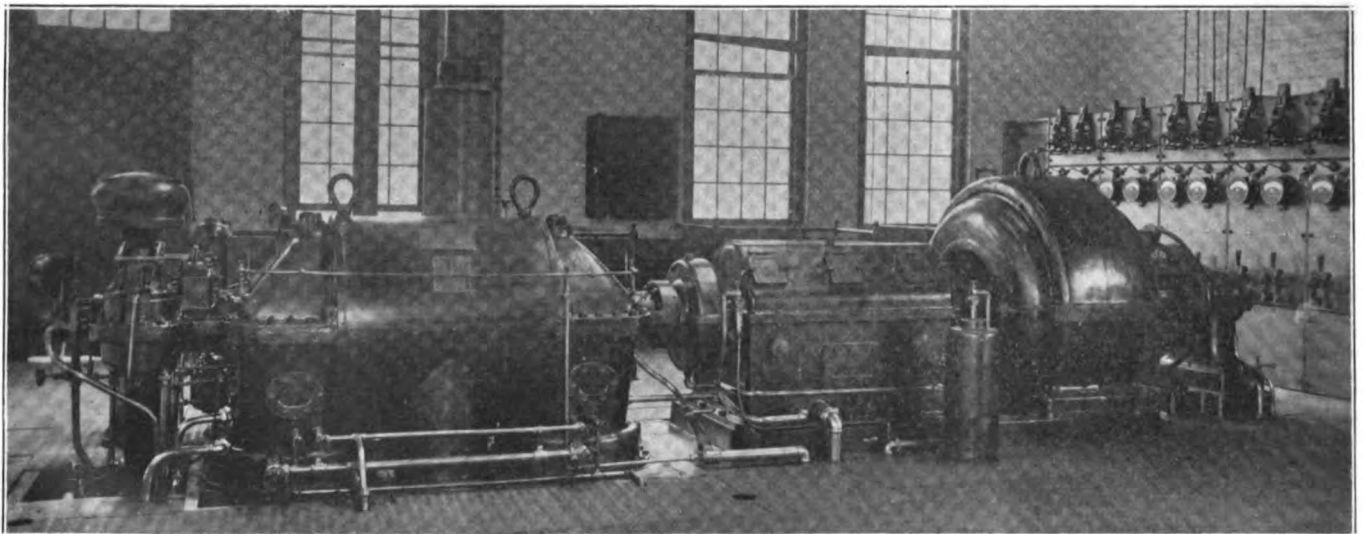


Fig. 1—500 kw Westinghouse 3,600 rpm low pressure turbine with double helical gear and a 900 rpm 250 volt dc generator.

get more power while the demand for steam was already up to the maximum capacity of the existing boiler plant.

The heat in steam and available for conversion into energy from atmospheric pressure to 28 inches of vacuum is almost equal to the heat available between 150 pounds boiler pressure and atmospheric exhaust. Therefore, by utilizing this heat in the exhaust steam by means of a steam turbine designed to operate on exhaust or low pressure steam the capacity of this plant could be considerably increased—almost doubled.

The problem was carefully considered and it was decided to install a turbine generator unit of sufficient capacity to take care of the new equipment plus the power required for driving one of the large compressors, the

In another plant whose conditions were quite similar to those given above, the mills were equipped with direct current service throughout, and, in order that the greatest flexibility might be maintained without changing over to alternating current a dc geared turbine unit was installed.

Fig. 1 shows the 500 kw Westinghouse 3,600 rpm low pressure turbine with its double helical gear and a 900 rpm, 250 volt dc generator.

Gears of this type have long since passed the experimental stage, have been thoroughly proven and are as capable of giving as satisfactory performance as the direct coupled unit. At the same time the turbine is permitted to run at its most advantageous speed—a high speed—while the dc generator is operated at a compar-

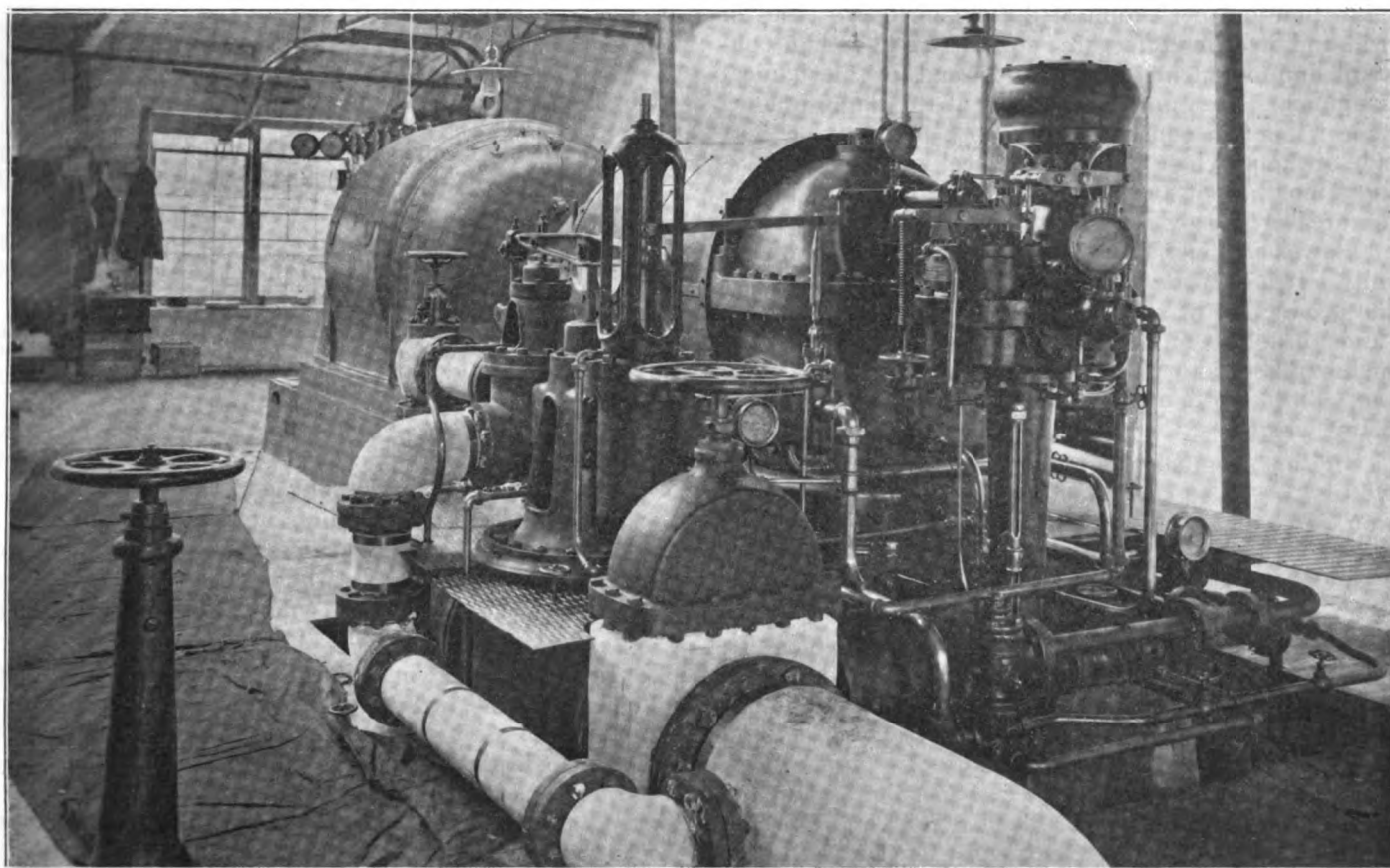


Fig. 2—750 kw low pressure Westinghouse turbine unit operating on exhaust steam.

latter being changed from steam to motor drive. This latter step, of course, was due to the condition that there was enough exhaust steam available to develop the desired power without requiring the exhaust from the compressor which was changed over to motor drive, and in this way the total steam demanded from the boilers was actually reduced.

The turbine unit installed, Fig. 2, was a 750 kw Westinghouse low pressure unit operating at 3,600 rpm, with electrical characteristics of three-phase, 60 cycles, and 480 volts, at 80 per cent power factor. Its capacity was sufficient to take care of the new equipment, the converted motor driven compressor and the condenser auxiliaries which were made motor driven to keep down the steam demand.

atively low speed where it gives its most satisfactory operation.

EDITOR'S NOTE—The use of exhaust steam unquestionably opens a field for a great deal of conservation of power. It is particularly to be pointed out that there is not much use in making careful studies of rolling operations, steam consumption in drives, etc., if an equivalent amount of power is later wasted in the exhaust. The wartime basis of production at any cost has ceased and the point brought out in this article is worthy of study in meeting competition costs of steel manufacture. Economy in steam consumption will be given greater study as competition becomes more keen, and this latter condition does and will exist to a greater extent as the industry approaches normal.

Combustion Control in Mill Boiler Plant

Factors Concerning Economical Production of Power—Causes of Boiler Plant Losses—Burning Coal—Chimney Gases—Incomplete Combustion—Fuel Losses Through Grate—Moisture in Fuel.

By ROBERT JUNE
Mechanical Engineer.
PART I.

The business of a steel mill is to produce iron and steel products as economically as possible. In the search for cheaper means of production, a great deal of attention has been paid in recent years to the simplification and perfection of the technical processes of iron and steel manufacture; so that we have had constant improvements in methods and in mechanical equipment. It is unfortunate that at the same time we have not given equal attention to a factor lying outside of the province of technical steel making, but having a most important bearing on the cost of the manufactured article—we refer to the production of power.

Power can be manufactured economically or wastefully. It is of little avail to perfect a new process for the production of steel plates say, and to spend thousands of dollars on the installation of necessary equipment, in order to reduce production costs 25 cents a ton, when two or three times that amount per ton is being wasted in the power plant.

In the economical production of power the first step is to secure control of the processes of combustion. In order to get at a thorough understanding of our problem, let us see what happens when we throw a shovel of coal into the boiler furnace.

Coal and air, the raw materials of combustion are composed of a number of elements, which must be taken into consideration in arriving at an understanding of the cause of waste. Coal consists largely of carbon, hydrogen, oxygen, sulphur and earthy material and ash. Air is made up principally of oxygen, nitrogen and water vapor. In the furnace, these elements behave in the manner in Table 1.

If carbon and oxygen are brought together at a high temperature, 12 parts of carbon will unite with 32 parts

Our only source of oxygen is the air, which is composed of 23 per cent of oxygen and 77 per cent nitrogen by weight, so that to supply 1 pound of oxygen to the coal it is necessary to supply air as follows:

$$\frac{100}{23} = 4.35 \text{ lb. of air}$$

which includes $\frac{77}{23} = 3.35$ pounds of nitrogen.

In order to burn completely 1 pound of carbon, 2 2/3 pounds of oxygen are required and 3 2/3 pounds of carbon dioxide are formed.

As 3.35 pounds of nitrogen are introduced with every pound of oxygen, it follows that for 2 2/3 pounds of oxygen, 8.92 pounds of nitrogen are used.

The result of burning 1 pound of pure oxygen in air is therefore

$$\begin{aligned} &3.67 \text{ lb. of CO}_2 \\ &8.92 \text{ lb. of N} \end{aligned}$$

$$12.59 \text{ lbs. of flue gases.}$$

As the ash in coal requires no air, and hydrogen is present in but minor quantities, the theoretical amount of air required to burn carbon is approximately that required for the complete combustion of a pound of coal—that is 12 pounds of air in a perfect furnace.

In the actual furnace it is necessary to supply more than the theoretical amount of oxygen. The percentage of excess air depends upon the size and character of the coal, kind of furnace and grates, depth of fuel bed, method of firing, draft, and other variables. But it may be set down as an axiom that where much over 40 per cent excess air is used for combustion, there is something radically wrong.

The cooling effects of various percentages of excess air are indicated in Table 11.

So far as concerns the efficiency of steam production, it would make no difference at all what the temperature of the fire was or whether 12 or 120 pounds of air were used for each pound of coal, so long as the fuel was completely burned and the boiler surface large enough to absorb all the heat in the gases. With an ideally perfect boiler that could absorb heat from gases until they were cooled down to air temperatures, it would be immaterial how much air had been used to burn the coal, or what the temperature of the gases was, because all their heat would be absorbed. Unfortunately, it is impracticable to build boilers of this kind. Heat cannot be absorbed effectively by a boiler from flue gases which are much cooler than 500 to 600 degrees F. Furthermore, this temperature is usually

TABLE 1.

Name of element	Chemical symbol	What happens in the furnace	Amount of oxygen required to burn	Combines with oxygen to form	Amount of air in lb. required to burn 1 lb.	Heat developed in Btu by complete burning of 1 lb.
Carbon	C	burns	2.66	CO ₂	11.57	14,000
Hydrogen	H	burns	.80	H ₂ O	34.80	62,000
Oxygen	O	doesn't burn	...	...	...	...
Nitrogen	N	doesn't burn	...	...	...	...
Sulphur	S	burns	1.0	SO ₂	4.35	4,050

of oxygen to form 44 parts of carbon dioxide, which means that 2 2/3 pounds of oxygen are required to burn 1 pound of carbon dioxide.

TABLE II.

Percentage excess air	Theoretical temperature of combustion F	Loss of temperature due to excess of air F	Loss expressed in terms of percentage	Relative boiler capacity, assuming 40% excess air as normal attainable practice of 100%
0	5132	0	0.0	100.0
10	4710	422	8.2	93.5
20	4352	780	15.2	88.2
30	4044	1088	21.2	83.0
40	3777	1355	26.4	78.5
50	3543	1589	31.0	74.5
60	3336	1796	35.0	70
70	3153	1979	38.6	63
80	2988	2144	41.4	56.6
90	2840	2292	46.7	51.5
100	2705	2927	47.3	47.0
125	2419	2713	52.9	
150	2188	2944	57.4	
175	1997	3135	61.1	
200	1837	3295	64.2	

required to produce the necessary draft, and unless the quantity of gas is kept down to a small volume the draft will be impaired because of the friction loss due to the resistance of fuel boiler and chimney.

With the actual boiler then, it makes a great deal of difference whether 12 or 120 pounds of air are used to burn 1 pound of coal. In one case 13 pounds of hot gas are going up the chimney, and in the other case 121 pounds. These hot gases are the chief "waste product" of the boiler plant or steam factory and they constitute the largest item in total waste of 40 per cent occurring in the average plant. Evidently the loss due to heat carried away by this waste product, is reduced by taking the minimum amount of air. But just as the factory manager must keep tab on his waste in order to eliminate it, so must the engineer measure the amount of his waste product in order to take steps toward its reduction. The amount of chimney gases per pound of coal is obtainable by measuring CO₂, or carbon dioxide; the heat in each pound of these gases is measured by their temperature. All of the important causes of loss in a boiler plant will be considered briefly and their extent pointed out, and, if possible, how much each may be reduced.

Heat Losses in Burning Coal.

A boiler, in order to utilize the heat of combustion of the fuel must be free from radiation and leakage losses, the fuel must be completely oxidized, and the products of combustion must be discharged at atmospheric temperatures. Commercially, such conditions are unobtainable, hence complete utilization of the heat generated is impossible. A boiler which utilizes 83 per cent of the heat value of the fuel is exceptional and an average figure for very good practice is not far from 77 per cent. The various losses including the heat utilized by the boiler, constitute the commercial "heat balance." The losses considered are:

1. Loss in the dry chimney gases.
2. Loss due to incomplete combustion.
3. Loss of fuel through the grate.

4. Superheating the hygroscopic moisture in the air.
5. Moisture in the fuel.
6. Unburned fuel carried beyond the combustion chamber in the form of soot or smoke.
7. Radiation and minor losses.

Some of these losses are preventable. Others are inherent, and cannot be avoided.

Loss in the Dry Chimney Gases.

This is usually the greatest of all losses. The type and proportions of the boiler and setting, and the driving rate, and factors which govern it. The amount of heat carried away, under varying conditions, is shown graphically in Fig. 1.

It will be noted that the extent of air dilution and

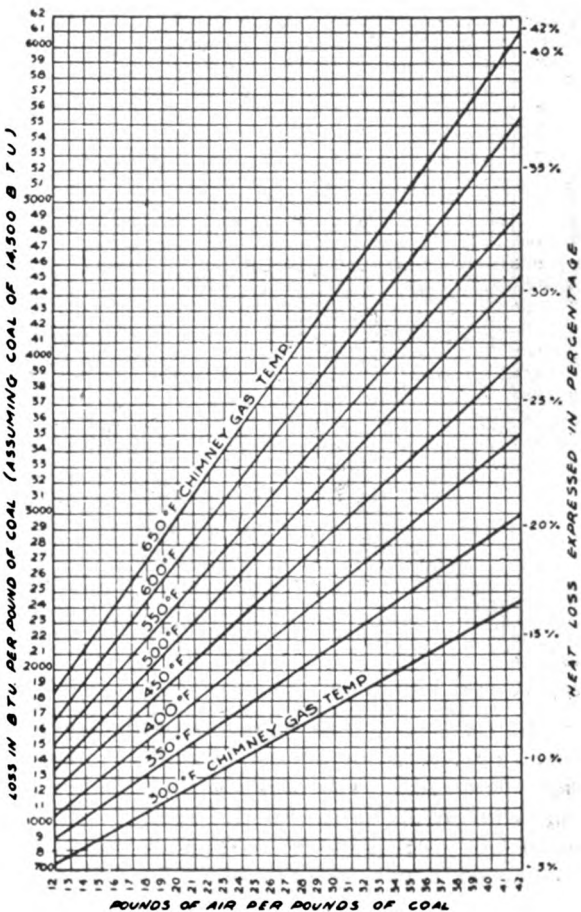


Fig. 1.

the temperatures at which the gases leave the boiler, indicate the magnitude of the loss. Flue temperatures less than 450 degrees F., are seldom experienced except in connection with economizers, and as the air dilution is ordinarily well over 40 per cent, the loss from this cause may range from 8 to 40 per cent of the total heat generated.

The amount of this loss can be cut down by reducing the weight of the heat-bearing gases, by only admitting to the furnaces the minimum practical amount of air, by preventing leaks in the furnace setting, and

by reducing the temperature of the gases, by keeping the fire surface of the boiler clean through the use of mechanical soot blowers. CO_2 analysis is available in determining this loss and furnishing a basis on which to lessen it.

Loss Due to Incomplete Combustion.

If the volatile gases are not completely oxidized, as when the air supply is insufficient or the mixture of air and gases is not quite thorough, some of the hydrocarbon may also pass through the furnace without

indicated losses ranging from 1.5 to 50 per cent of the heat value of the coal at normal driving rates.

This loss can and should be reduced by proportioning the grate openings to suit the size of the coal burned, careful handling of the fire, and, when practicable, the substitution of free-burning for caking coals.

Loss Due to Superheating Moisture in Air.

This loss is, in the main, a minor one, ranging from 2 to 4 per cent, except on hot, humid days or at plants located at points of excessive rainfall or near the sea coast. As it cannot be controlled, except as excess of air is controlled, it is not discussed further.

Loss Due to Moisture in Fuel.

If present in large quantities, moisture in the fuel represents an appreciable loss in economy, since the heat necessary to evaporate it into superheated steam

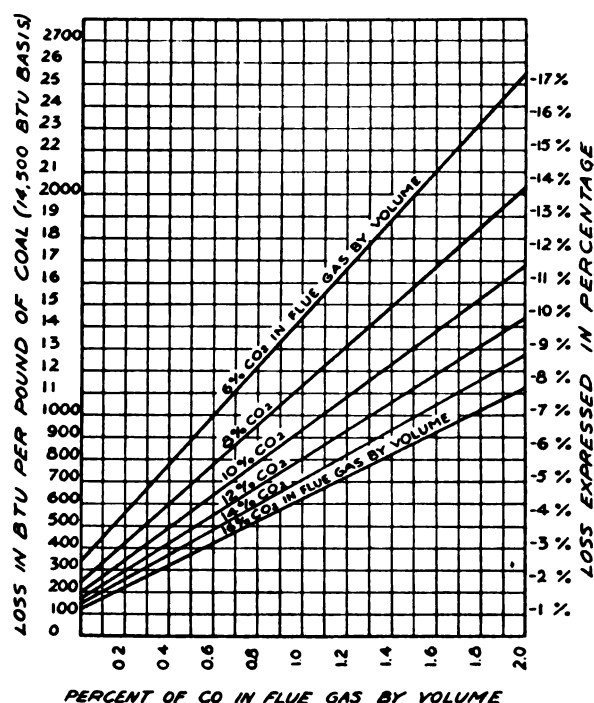


Fig. 2.

being burned. The presence of even a small amount of carbon monoxide (CO) in the flue gas is indicative of appreciable loss, as will be seen from Table II.

If the furnace is properly designed, these losses may be reduced to an almost negligible quantity by careful operation. With a good and even fuel bed, having a thickness suited to the effective draft, only traces of CO , hydrogen, etc., should be found. If the losses exceed 2 per cent, there is something wrong and pains should be taken to find out whether the trouble is due to poor design or careless firing, so that it can be eliminated.

Loss of Fuel Through Grate.

In average practice the unconsumed carbon found in the ash pit ranges from 15 to 50 per cent of the total weight of dry refuse, depending upon the size and quality of coal, type of grate and rate of driving. This loss of fuel runs from 1.5 to 10 per cent or more, of the total heating value. Although various attempts have been made to assign an average percentage to this loss, they have been without result or value. Numerous tests of recent mechanical stoker installations have

at chimney temperature is lost. Firemen occasionally wet coal to assist coking or reduce dust, but moisture thus added necessarily reduces the theoretical furnace efficiency.

Under certain conditions, wet coal may give a higher evaporation than dry coal, that is, through a purely mechanical action, the moisture may assist in packing the coal, thus reducing the loss through the grate, or in cases of thin fires, reduce air excess. The occasions when the application of the hose to the coal pile is warranted are of limited frequency, however, and the firemen should be under strict instructions never to apply water without the specific consent of the boiler-room foreman.

It follows, from what has been said, that coal known to be high in moisture should not be purchased without adjustment of prices to compensate for lowered efficiency.

Next month we will discuss the losses due to presence of hydrogen in the fuel, losses due to visible smoke, radiation and unaccounted-for losses, and will then take up the question of choice and use of necessary boiler room instruments.

This is the first of a series of articles which Mr. June is writing for the Blast Furnace and Steel Plant, in which he will discuss all of the important causes of loss in a boiler plant. Methods will be suggested to reduce these losses. Mr. June points out in this article that power can be manufactured economically or wastefully and that it is of little avail to perfect a new process of steel in order to reduce production cost a few cents a ton when three or four times that amount is wasted in the power plant.

Economical Fuel Burning Equipment

Eighty Per Cent Combined Boiler, Stoker and Economizer Efficiency Possible—Ash Disposal Mechanism—Typical Installations Described—Operating Data Shows Economic Results.

By J. G. WORKER,

Manager Stoker Section, Westinghouse Electric & Manufacturing Co.

The organization of the steel industry, on a war basis, with the enormous increase in steel production which it involved, created a demand for stoker equipment and operating methods which would yield the greatest economical results. Even now, during the reconstruction period, the effects of the fuel conservation campaign is still directing attention to securing fuel burning equipment in steel mills that is better than what is now ordinarily used. It is significant to note that the inclined multiple retort underfeed stoker, Fig. 1, is finding wide application in steel mill power-plant equipment. In fact, there are now a number of such installations in steel mills, and indications are that this stoker equipment is distinctly growing in favor.

when operating at capacities of 200 to 250 per cent rating, the drop in capacity will be 25 or 50 per cent. The drop in steam pressure is generally very slight.

In some installations, these dumping grates are operated by a steam cylinder, a hydraulic cylinder or an electric motor. Fig. 2 shows the connection of the steam cylinder to the dump grate shafts, the entire mechanism being located at the side of the boiler.

The dump grates are held in position by the pawl at each end. Just before dumping, these are released. The cylinders are so arranged that both grates may be operated together, or singly. At an installation in the plant of the Minneapolis Street Railway Company, it was found, by actual test, that $1\frac{1}{2}$ minutes was the

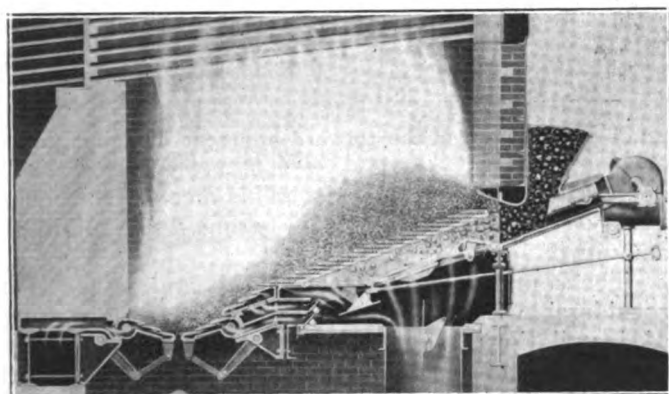


Fig. 1—Sectional view of multiple retort stoker, showing fuel bed and method of air distribution.

Ash Disposal Mechanism.

The adaptability of this stoker to different kinds of fuel and operating conditions is of utmost importance. For example, there are two methods for removing ash from the stoker—intermittent and continuous. Under the first, comes the standard hand-operated dump grate and three types of power-operating dump grates, namely, steam, hydraulic and electric. Under the second, comes the rotary ash discharge.

Fig. 3 shows the multiple inclined underfeed stoker equipped with the standard hand-operated dump grate which is popular among some stoker users, for the reason that if anything happens, the fire can be dumped and then gotten into condition for continuing service. The tendency with this type is for boiler operators to let the combustible burn out of ash quite thoroughly before dumping. With proper operation, the average time required to dump is five minutes, and

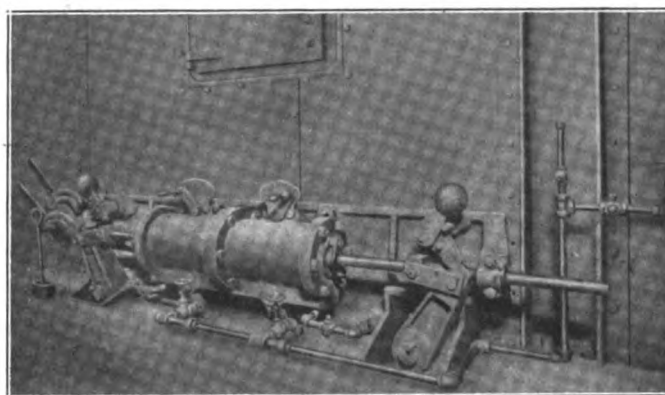


Fig. 2—View of steam cylinder mechanism for operation of forward and rear dumping grate of multiple retort inclined underfeed stokers.

time required for dumping. The air pressure was off for only 30 seconds. The CO_2 percentage returned to normal in five minutes, and the drop of 15 to 25 degrees in the flue gas temperature lasted only 10 minutes. The boiler was operating at 200 per cent rating, but there was no drop in capacity or pressure. The coal used had the following analysis:

Moisture	21.98%
.. Volatile matter	31.41%
Fixed carbon	43.77%
Ash	21.10%
Sulphur	2.76%
Btu (as fired)	8,784

The facility with which the fire should be cleaned and maintained in proper condition led to a very low per cent of combustible in ash. The following figures are typical:

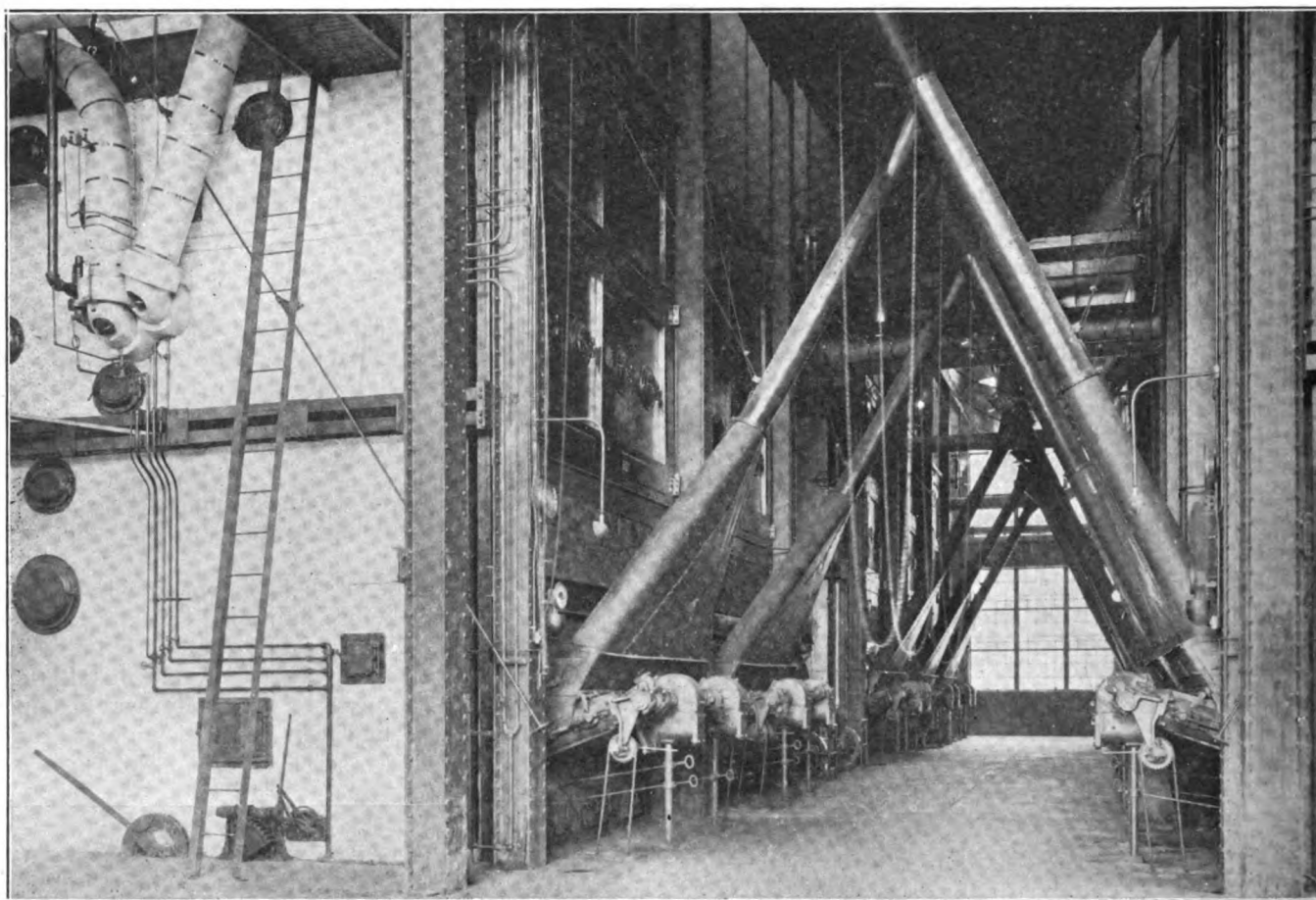


Fig. 3—View showing side wall of boilers equipped with hand-operating mechanism for the forward and rear dumping grates.

Date	Average Boiler Rating	Combustible in Ash
February 25, 1919	143.7%	9.6%
February 27, 1919	175	10.9%
March 5, 1919	161	14

The electric dump mechanism is shown in Fig. 4. It is arranged with a right-hand and left-hand worm so that either grate may be lowered with the motor operating in one direction. Limit switches are provided to prevent over-traveling in either direction. From an actual test at the L-Street station of the Boston Edison Company, the time required to open

one grate is 40 to 45 seconds. This mechanism is also a very compact arrangement, taking up a minimum amount of space.

The continuous discharge of ash and refuse is of considerable importance, especially for certain types of installations. For these special conditions, the rotary clinker grinder, Fig. 8, has been developed. One of the first installations of this type of grinder is now operating at the L-Street station of the Boston Edison Company. The boiler has been operated up to 300 per cent of capacity with the continuous discharge of ash and refuse working in a most reliable way. With this design of grinder, the combustible in the ash and refuse is very low. The clinker grinder has been applied to the large boilers installed at the Delray Station, Detroit Edison Company. These have been in operation for some time, and the following results were obtained insofar as the combustible in the ash is concerned:

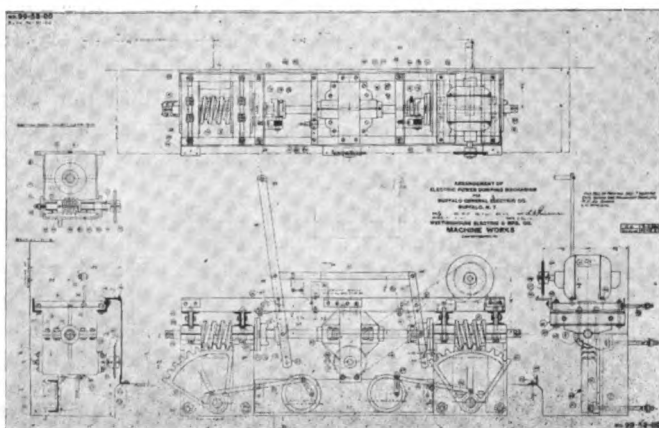


Fig. 4—Arrangement of electric power dumping mechanism designed for multiple retort inclined underfeed stokers at Buffalo General Electric Company, Buffalo, N. Y.

Date.	Percent of Combustible in Ash and Refuse.
April 30, 1918	10.15
May 6, 1918	14.18
May 20, 1918	5.08
June 3, 1918	13.00
June 10, 1918	11.10
July 29, 1918	19.28
August 5, 1918	14.80
August 13, 1918	12.85
August 19, 1918	13.50

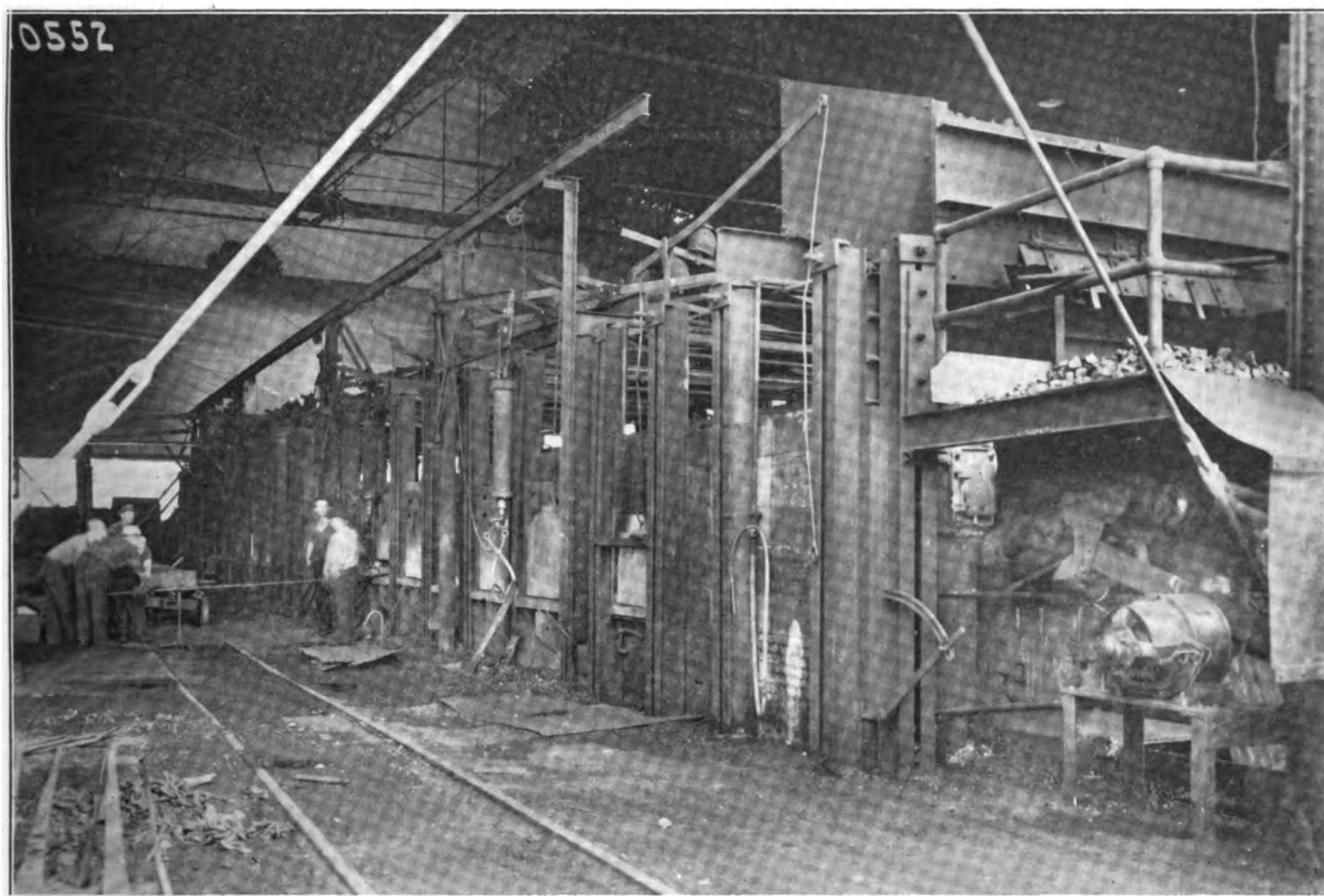


Fig. 5—General view of billet heating furnace showing method of driving underfeed stoker with motor—Spang Chalfant Co., Pittsburgh, Pa.

The coal used at the Delray plant is West Virginia, average 134,40 Btu per pound, with 10 per cent ash.

National Tube Company Installation.

The installation of this type of stoker in steel mills is being favorably considered on account of the high capacities that can be obtained from boiler equipment and the wide range of economical operation. Large boilers of 1,200 to 1,500 hp are being used, a typical installation being that of the National Tube Company, McKeesport, Pa. This installation consists of two 1,471 hp cross-drum Babcock & Wilcox boilers, each equipped with 12-retort Westinghouse underfeed stokers. The stoker is placed under the rear of the boiler. The bridgewall in this case is the front wall of the boiler, doors being placed in the front so that complete observation of furnace condition can be made.

Spang-Chalfant Installation.

Figure 7 shows the interior view of the underfeed stokers installed at the Spang-Chalfant plant, Pittsburgh, Pa. The engineers of this company have done considerable work in developing the multiple retort underfeed stoker to suit steel mill conditions. The boiler and stoker equipment at the Spang-Chalfant plant, consists of two 500 hp Ladd boilers, each boiler being equipped with a 9-retort Westinghouse underfeed stoker. The merit of this application is the large combustion space, and the elimination of arches

over the fuel bed. This is one thing that operating engineers are particularly interested in. As a general rule, the underfeed type of stoker does not require arches over the fuel bed. Arches are very troublesome, not only from a reliability standpoint, but from a maintenance standpoint.

The underfeed stoker has worked out so satisfactorily at the Spang-Chalfant plant that they have been installed in connection with billet heating furnaces. Fig. 6 shows the application of the multiple retort underfeed stoker at the end of the heating furnace.

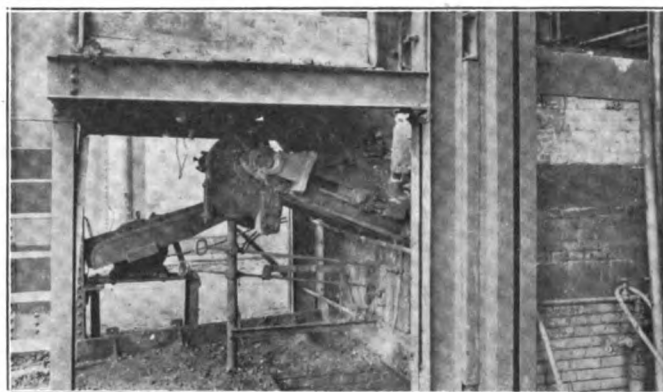


Fig. 6—View showing stoker applied to billet heating furnace—Spang Chalfant Company, Pittsburgh, Pa.

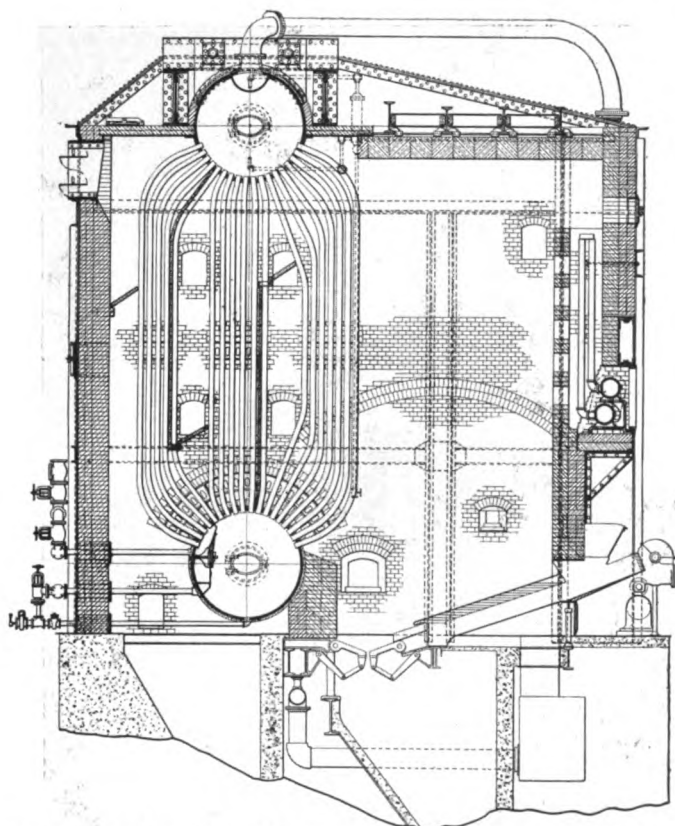


Fig. 7—Interior view of Spang Chalfant Company underfeed stoker installation, applied to Ladd boilers.

The platform above the stoker rams is used for feeding coal into the stoker hoppers. Fig. 5 shows the general construction of the heating furnace, the motor operating the underfeed stoker being shown in the foreground.

Possible Economic Results.

The combination of the underfeed stoker to water

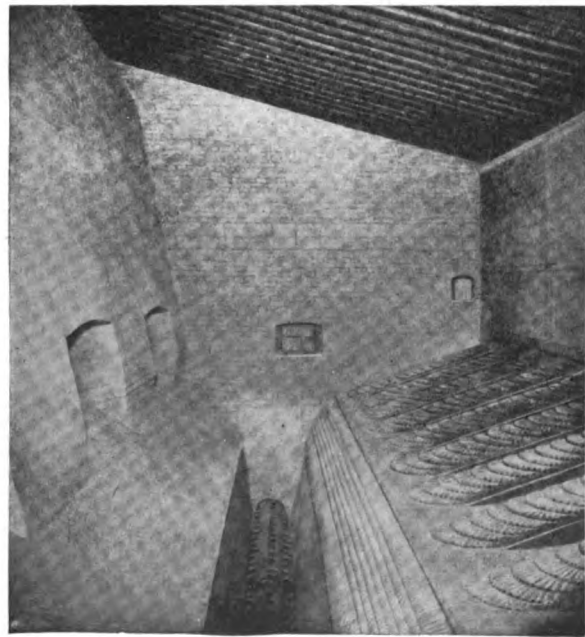


Fig. 8—Interior view of furnace with single roll clinker grinder.

tube boilers has given extremely good results. From recent test date obtained on typical combination of water tube boilers and underfeed stokers, the following results were obtained:

Draft over fire	.06
Draft between damper and economizer inlet.....	.97
Draft at economizer fan	1.47
Stoker windbox pressure	2.80
Steam pressure gauge	254 lbs.
Temperature of gases leaving boiler.....	611° F.
Temperature of gases leaving economizer.....	327° F.
Temperature of water entering economizer.....	139° F.
Temperature of steam	655° F.
CO ₂ in boiler gases	14.1
Coal per ram stroke.....	18.17
Total water fed per hour, lbs.....	116,000
Factor evaporation boiler	1.155
Factor evaporation boiler and economizer.....	1.275
Evaporation from and at 212° F. B.H.P.....	133,980
Evaporation from and at 212° F. boiler and economizer hp.....	147,900
Hp developed by boiler	3,880
Hp developed by boiler and economizer	4,280
Per cent rating developed by boiler	307
Per cent rating developed by boiler and economizer	339
Hp developed by economizer.....	400
Hp developed by economizer to boiler rating....	3.16
Pounds of coal fired.....	84,454
Pounds of coal fired per hp.....	14,076
Pounds of coal fired per retort hp.....	1,005
Evaporation from and at 212° per lb. of coal as fired for boiler, pounds.....	9.50
Evaporation from and at 212° F. per lb. of coal as fired boiler and economizer, pounds.....	10.50
Btu coal as fired	12,800
Efficiency boiler, furnace and grate, per cent....	72.2
Efficiency boiler, furnace, grate and economizer, per cent	79.9
Cleaned fires at 9.25 a. m.—12 o'clock, noon.	

In reviewing the above figures, it should be noted that 116,000 pounds of water was evaporated per hour with a combined efficiency of boiler, stoker and economizer of approximately 80 per cent, which was practically 307 per cent of boiler rating for a duration of six hours. Those witnessing the test stated that there was no reason at all why these results could not be obtained indefinitely. The tests were conducted for certain engineering information and not for commercial purposes or to show fulfillment of any guarantees, and they are given here merely to show the possibility of obtaining 80 per cent combined efficiency with medium coal, a good boiler, good economizers, and the proper fuel-burning equipment. Engineers are slow in accepting such performance as every-day operation, but these results are now being obtained in every-day operation, and those who are contemplating new equipment should, by all means, provide for these results.

A study of the fuel burning equipment of the most modern plants will show that every consideration is being given to those details which provide for a balancing of the economic results that come from a careful selection of equipment, good supervision and correct operation. It will be found that elaborate means are being provided so that the boiler room organization can do things easily.

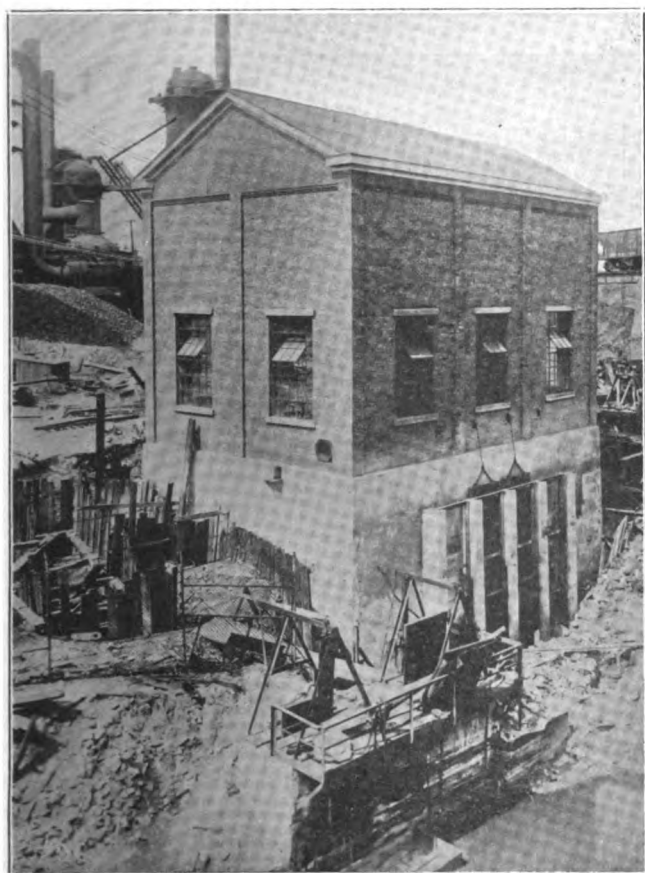
Unique Pump House for Blast Furnace

Condenser and Cooling Water Installation Installed Under Difficult Circumstances and Unusual Conditions — Installation of Pumps Below Water Line and Simplicity of Piping Arrangement.

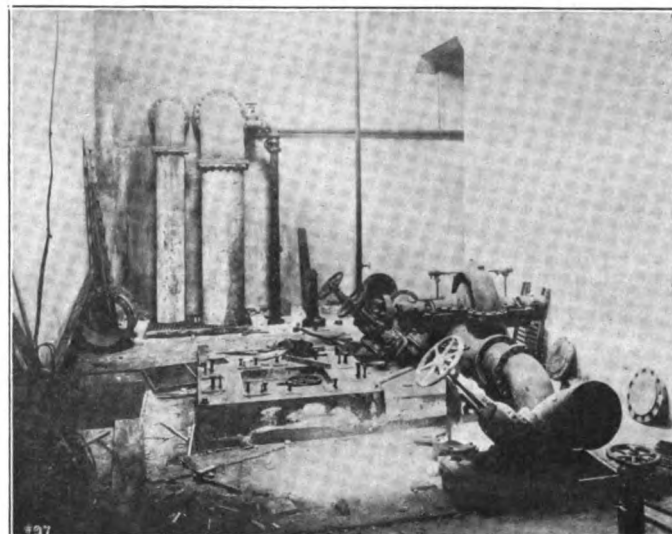
A pump house embodying several unique features is being completed at the plant of the Struthers Furnace Company, Struthers, O. The water pumped from the Mahoning river supplies the water for the condensing plant of the blowing engines and for the blast furnace cooling water. The chief features of the installation are: Installation of pumps below water line; simplicity of piping arrangement; duplication of both

ultimate capacity of the intake will be 25,000,000 gallons in 24 hours. The pump house is arranged for four pumps, each of 6,000 gallons per minute.

There are four separate intake chambers, anyone of which may be shut down while the others are in operation, and anyone of which may be pumped dry while the others are in full operation. From each suction chamber, there is 24 inch discharge line into a 24 inch valve into a 24 inch suction header. There are four branches from this suction header for the four pumps. A 24 inch gate valve in the middle of the suction header allows the shut down of one half of the header, while the other half is in full operation. Shutting down one-half the header entails the shutting down of two of the pumps only. In each suction branch to the pumps, there is a gate valve at the pump. The pumps discharge into separate discharge headers which connect, in the case of three pumps, into a 24-inch dis-



Exterior view of pump house.



Portion of interior of pump house.

suction and discharge piping; ventilation of pipe chamber in the pump house; and single crane over both intake and pump house. The pumps are manufactured by the Allis-Chalmers Company, and the water traveling screens by the Chain Belt Company. The combination intake and pump house together with the piping were designed and installed completely by the Baker-Dunbar-Allen Company, with the cooperation of the engineers of the Struthers Furnace Company.

The intake is designed for an ultimate of four traveling screens, two to be installed at present. The

charge header which runs through a 24-inch check valve directly to the standpipe. The fourth pump connects to a 16 inch discharge header through a check valve to the condenser installation.

These two lines are cross connected at their beginning, just before reaching the standpipe, in such a manner that the 24 inch line may be used for supplying either the standpipe or the condensers or both, while the 16 inch line is not in service; and vice versa. The 16 inch line may be used for supplying the standpipe or supplying the condenser or both while the 24

inch line is not in service. All piping in the pump house is below the pump floor in what is termed the pipe chamber. It is seven feet high; will be electrically lighted, and all piping so arranged that a man can conveniently work upon same. The piping from the intake is always dry. The pumps are located in the floor above this, and the entire floor area is open above the pump floor with the exception of a balcony at the pump house entrance level.

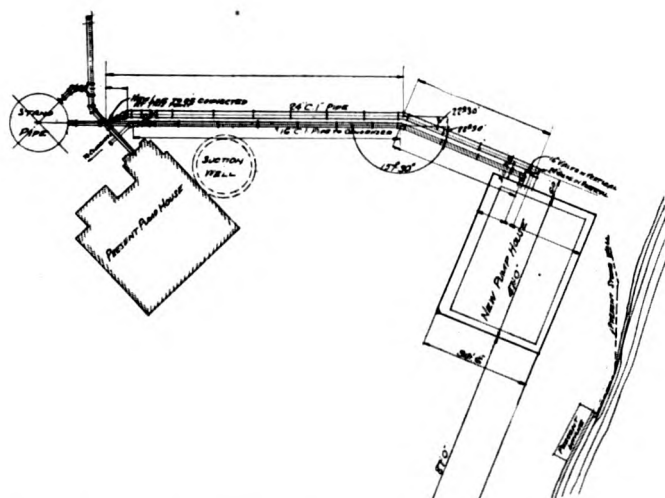
The pipe chamber is maintained dry of condenser moisture by means of a sloping the floor to a center trench which discharges into a sump pit. In this pit is mounted a vertical pump direct connected to a vertical motor mounted on the pump floor.

The floor level of the center line of the pumps is below low water level of the river, which means that the pumps always have a positive suction, therefore, never require priming. The ventilation of the pipe chamber and the pump house floor was a serious mat-

located, is filled with refuse discharged from the mills. A particularly aggravating material is blast furnace slag, which enters in divided state normally somewhere around $\frac{1}{8}$ to $\frac{1}{4}$ of an inch diameter. This material will be largely taken out of the water by traveling screens which have a mesh of $\frac{1}{8}$ inch. These traveling screens are motor operated to automatically take the refuse out of the water, and discharge same in a trough to the down-stream end of the pump house into the river.

The water supply at this point of the Mahoning river is inadequate for the use of the mills. In consequence, it is reused many times, it being estimated that the entire flow of the river runs through the mills 200 times before it is allowed to be discharged. As a result, the water at the point of the pump house has reached a temperatures as high as 130 degrees F.

As a consequence, installing a pump at such an



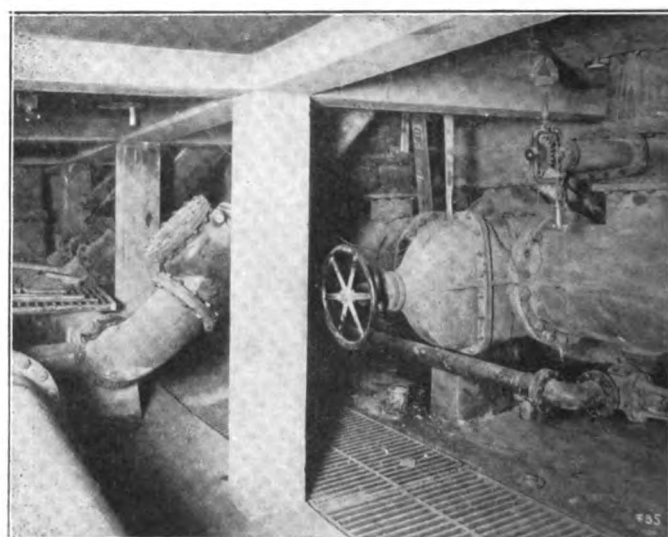
General arrangement of piping for pump house of Struthers Furnace Company.

ter due to the collection of sewer gases. On the level of the entrance, therefore, is installed a ventilating fan, suctioned from the outside air with discharge ducts running into the pipe chamber. The entire pipe chamber normally operates at a pressure above atmosphere. This will allow of the complete changing of the air in the entire pump house once in every 10 minutes, through ventilators in the roof, and fenestra sash in the side walls of the superstructure.

All the main pumps are electrically operated, as is the sump pump. One common switchboard on the pump floor level will operate all of these pumps.

The superstructure is a steel building with walls and high grade roof and covers not only the pump house but the intake. Running cross the superstructure is a 10-ton hand operated crane to allow the removal of any of the machinery within either the intake or the pump house, this including the traveling screens complete, as a unit.

The Mahoning river, on which this pump house is



Pump pit seven feet high and electrically lighted, facilitating any work which may have to be done in the pit.

elevation that vacuum is required to pull the water into the pump is extremely hazardous. The water, due to the high temperature, would flash into steam at comparatively low vacuum. This condition is entirely obviated by the installation of the pumps below the minimum water level. In order to install these pumps at this level, it was necessary to dredge 4,000 or 5,000 yards of earth away from the pump house and dump same farther back on top of the bank.

The entire installation was made on piling about 15 feet long as the bottom elevation of the pump house and intake was at an elevation of a 6 foot strata of quicksand. The round piling was put down to rock.

This installation is considered unusual in that it makes feasible a very difficult pumping situation, and further that the construction work itself was carried on under extremely bad conditions because of quicksand. Taking all things into consideration the work of designing and installing this pump house may be considered as a considerable engineering feat.

Suggestions for Correct Boiler Baffling

Study of Existing Installations—Gas Velocity Should Permit Maximum Heat Transfer—Improving Present Plants by Logical Baffling for Better Results Without Entirely Rebuilding.

By A. D. WILLIAMS.

(Copyrighted 1919, by A. D. Williams.)

Heating or the application of heat to industrial and domestic processes is an engineering problem of importance. A study of existing installations reveals many interesting discrepancies in practice. In writing about the heating furnace a great deal has been said regarding the importance of permitting the heat to soak in. It is well known that a time factor is necessary. Pretty nearly every one has been guilty of the very dangerous "kid trick" of jumping through the flame of a bonfire and

this result will be enormous. When the velocity of the flowing gas becomes infinitely slow the difference between the final and initial temperatures of the gas will be large, and will gradually decrease as the surface past which it flows approaches the temperature equilibrium. The rate of heat transfer will be low and the rise in temperature of the heated surface will be slow. The amount of hot gas required will be a minimum, as the gas will leave the surface at a temperature slightly higher than the temperature of the exit edge of the heated surface.

The ideal condition is found between these two extremes. In boiler practice the problem is to pass the gases by the recipient surface at a velocity which will permit them to give up or transfer all of the heat they carry between two temperature limits. Their initial or high temperature limit is fixed by the firebox or combustion temperature. Their final or low temperature limit is fixed by the ruling temperature or temperature of régime of the boiler plus the temperature required to supply a temperature head necessary for the transfer of heat. This final temperature of the gases should be somewhere between 200 and 300 degrees C. Frequently it is much higher.

The firebox temperature will be fixed by the calorific intensity of the combustible as limited by the quantity and temperature of the air supply and the condition of the firebox chamber. Unless the firebox is so designed and constructed that the entire combustible supplied by the fuel is completely burned within it, unconsumed gases will be carried to a point where they will be exposed to the refrigerating action of the water-cooled surface of the boiler. This results in checking combustion and the dissociation of carbon monoxide forming carbon dioxide and soot or carbon.

Another point to be considered in connection with gas velocities arises from the fact that the carrying power of the flowing stream varies with the sixth power of its velocity. This means that doubling the velocity of flow enables the flowing stream to increase the weight of the particles carried in suspension 64 times. These heavier particles are more readily thrown out of the stream into the eddies where changes of direction occur. Soot blowers and the steam lance are employed to rid the heating surface of this dirt, soot, etc., instead of attacking the root of the trouble and thereby eliminating it, or at least reducing it to a minimum. The usual methods of setting and baffling boilers coupled with the design of the boilers themselves is well calculated to intensify combustion and soot difficulties. At the same time the troubles with existing plant may be considerably reduced by consideration of the laws governing the flow of hot gases.

Possibly the easiest way to obtain a conception of the

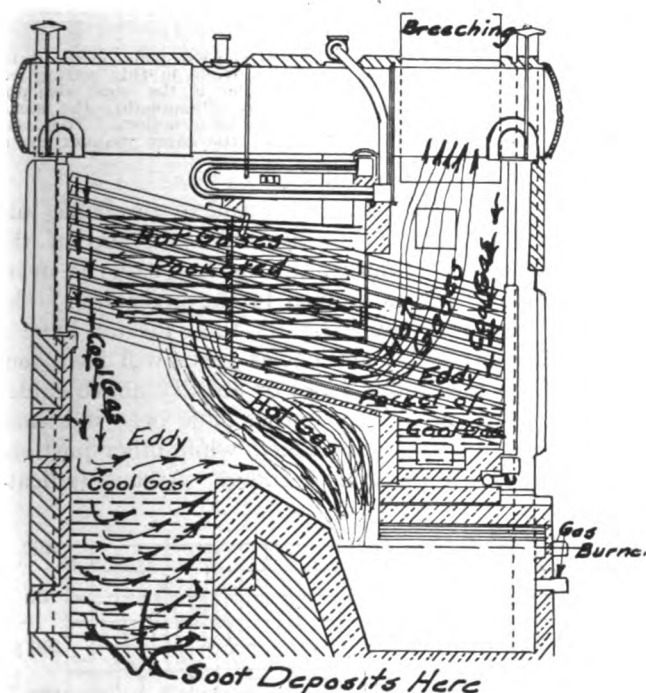


Fig. 1.

Diagram showing the flow of gases in a B. & W. type boiler with special setting. This boiler is gas fired. Temperature observations made in this setting by the Bureau of Mines are shown in Figs. 6, 3 and 5. The observations of temperatures made by the bureau indicate that the flow of the gases follows the laws of hydraulics. The hot gases behaving in the same manner as an inverted stream of water. By looking at this cut from the top instead of the bottom of the page this analogy may be clearly seen.

some have even run through it. But when boiler settings are considered a great deal has been said regarding the importance of high gas velocities as contributing to efficient operation.

It is very easy to demonstrate that when the hot gas flows past a finite surface with an infinitely high velocity the rate of heat transfer will be infinitely low. In this case the temperature drop of the flowing gas will be small. That is its initial and final temperatures will be very nearly the same. The surface past which the gas flows will gain in temperature at a very slow rate. It will require a very long time for it to reach a temperature equilibrium. The amount of hot gas required to attain

flow of hot gases is to consider the flow of water in a trough, and the way it passes over the end of the trough into a pail or other container. The trough for water must have a bottom and two sides, while that for gases lighter than air must have a top and two sides. The trough for water turned upside down or inverted. Prof.

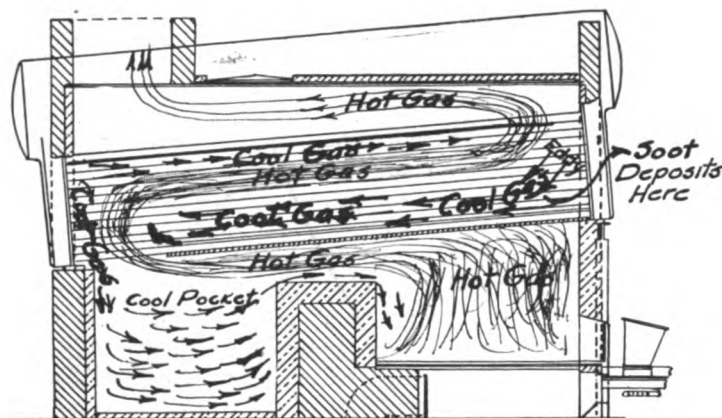


Fig. 2.

Diagram showing flow of gases in single pass horizontally baffled boiler. Underfeed stoker coal firing. Temperature measurements made in this boiler setting are shown in curves, Figs. 7, 9 and 4. By looking at this figure upside down the analogy to the flow of water will be clearly observed. This type of baffling is particularly well adapted for the formation of cool gas and soot pockets.

Groume-Grjmailo has investigated numerous types of furnaces by means of white metal sectional models with glass sides. Immersing them in an aquarium or tank with glass panels and connecting them so that he was able to pass a stream of colored kerosene oil through the model. The behavior of this stream of oil and the action of the water in the aquarium supplied considerable light upon the flow of the hot gases through the furnace. Working upon this analogy Prof. Yesmann was able to develop working formulas and their application to existing furnaces demonstrated the correctness of the assumptions made.

In April, 1919, the Bureau of Mines issued their Bulletin No. 145 on "Measuring the Temperature of Gases in Boiler Settings." The temperature curves plotted in this bulletin confirm in a very interesting manner the hydraulic laws governing the flow of hot gases. The illustrations in this article are taken from this bulletin and the only additional feature is that in three of the figures lines have been added to show the flow of the hot gases, the chilled gas and soot pockets and the flow

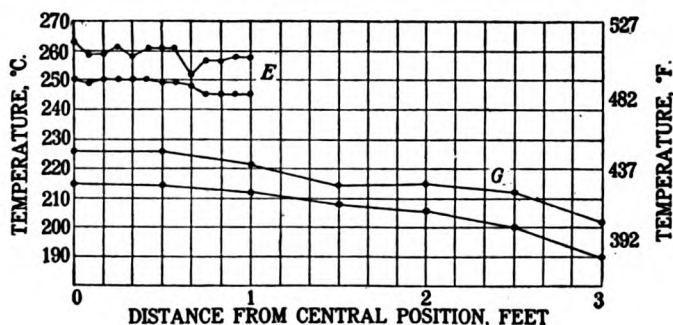


Fig. 3.

Curve showing variation in temperature at points E and G at different distances from the center line of the boiler shown in Fig. 1. Upper pair of curves shows the temperatures indicated by moving twin couple E 1-inch steps away from center line. Lower pair of curves show indications of twin couple G when moved by 6-inch steps away from the center.

of the chilled gases in Figs. 1, 2 and 3 of this article (Fig. 2, 4 and 6 of Bulletin 145).

Figure 1 shows a gas fired type boiler installed at the Carnegie Institute of Technology. By turning this figure upside down it will appear that the flow from the firebox falls on the inclined baffle on the

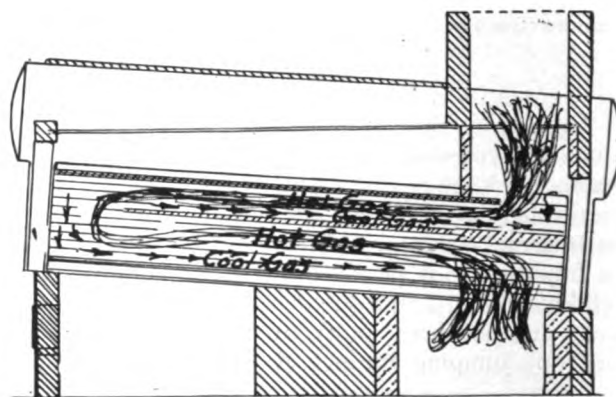


Fig. 4.

Diagram showing the flow of gases in two pass horizontally baffled boiler. Temperature measurements made in this setting are shown in curves Fig. 8 and 10. This boiler is the same size and make as the single pass shown in Fig. 2. Presumably the steam was generated at about the same rate in both boilers. The location of cool gas pockets is indicated in the same manner as in Figs. 1 and 2.

lower tubes and cascades over the end of the baffle into and among the tubes. Flowing under the top of the baffle. This flow continues until the last baffle is overflowed and a cascade is formed to the breeching. The hot gases being very much lighter than the air have a tendency to rise. Relatively cooler gases will have tendency to fall below hotter gases or stratify above colder air or gas. Portions of the setting have been indicated as forming cold or cool gas pockets while other portions are indicated as the location of eddies. Arrows indicate

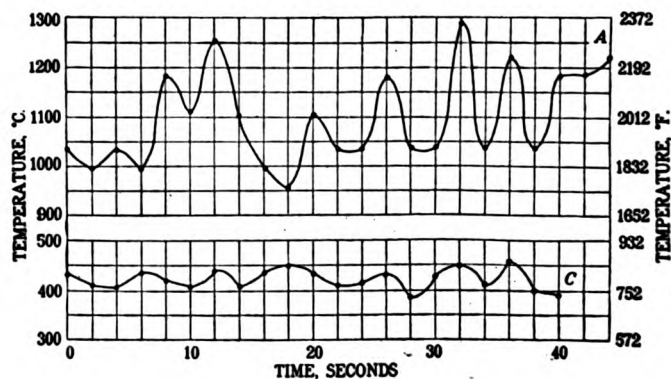


Fig. 5.

Curves showing the fluctuations of temperature at points A and C in the boiler shown in Fig. 1. The fluctuations were obtained by reading the small couple at two second intervals. These fluctuations are a beautiful illustration of the analogy between the flow of water and the flow of hot gases. Couple C is located near the bottom of the steam drum where it is immersed in a comparatively quiet body of gas. Couple A is located immediately below the tubes at a point where it would show the effect of all the surges in the stream of flowing gas. Anyone who has watched water flowing from the top of a dam or the spout of a pump has noticed that the flow is broken up by numerous small surges. This pyrometer curve shows the effect of the gas surges. Another factor contributing to these surges is the refrigerating action of the water cooled tubes on the gases. Chilled gases will be held among the tubes in the same manner as a ball is supported by a stream of water or air, until the weight of chilled gases becomes sufficient to permit it to break its way down through the up-flowing current of hot gas. Conditions similar to this exist with all the usual forms of boiler baffling as they are well arranged to promote this condition. One of the effects of this condition is the formation of soot and CO₂ by the dissociation of CO instead of its combustion. Considerable heat loss results.

approximately the flow of the cold and the hot gases. The pockets of relatively cold, chilled gases form banks of soot and dirt. Letters on this figure designate the points where the pyrometer couples were located.

Figure 6 shows the curve of temperature drop through the setting. One of the interesting features of this curve is the difference between the indications of the large and the small couples. It is rather important that the pyrometer couple be suited to the work. The large couples are better suited to obtain the average temperature as they have an inertia that prevents their responding to sudden differences due to the continual surging of the

vibration.

The slight amplitude of the temperature surges at C is due to the fact that this couple is located at a point where a pocket of hot gas occurs. This would hold the temperature within rather close limits and it is fairly probable that these surges are due, in part, to the infiltration of cold air, as these couples were located fairly close to the center line of the boiler. This location would bring them between the two drums at a point where cold air might drop on them from leakage. The air leaking in at this point would be heated by the brickwork. Stratification would not be likely at this location as the tubes

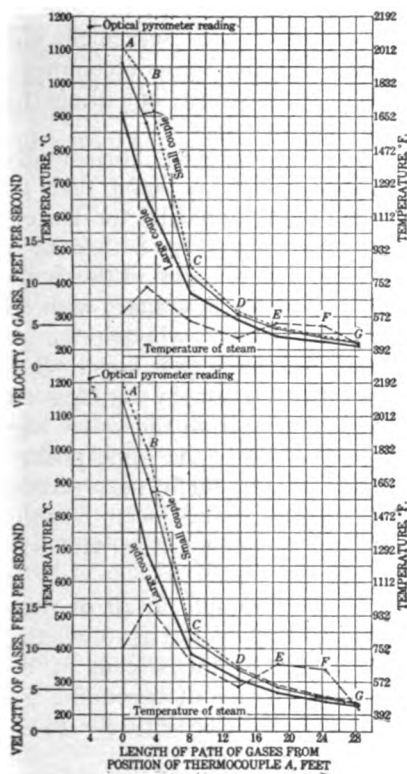


Fig. 6.

Fig. 6—Curve showing temperature of the gases flowing through the B. & W. type boiler setting shown in Fig. 1. The letters on the curve refer to pyrometer locations as indicated in Fig. 1. Solid curves show temperatures indicated by pyrometer couples. Dotted curve shows the computed temperatures from experimental data. Dash curve shows computed velocity of gases. This curve is probably based on the assumption that the flowing gases entirely fill the full area of the passage. As the basic assumption does not agree with the action of the gases in this matter, the true velocity curve will be much higher at certain points. Upper and lower diagrams show similar data for two different initial temperatures.

Fig. 7—Curve showing temperature of gases flowing through single pass horizontally baffled boiler. Positions of thermo couple are indicated by letters in Fig. 2. Solid line curves show temperatures indicated by couples. Dotted curve shows approximate computed true temperatures. Dash curve shows computed velocity of gases at different points. The velocity curve being, probably, based on the sectional area of the pass is erroneous. Upper and lower diagrams show similar data for two different initial temperatures.

Fig. 8—Curve showing the temperature of gases flowing through double pass horizontally baffled boiler in Fig. 9. Positions of thermo-couples indicated by letters. Solid line curves show temperatures indicated by pyrometer couples. Dotted line curve shows computed approximate true gas temperatures. Dash curve shows computed gas velocities, probably based on gases occupying full area of pass. Upper and lower diagrams show similar data for two different initial temperatures.

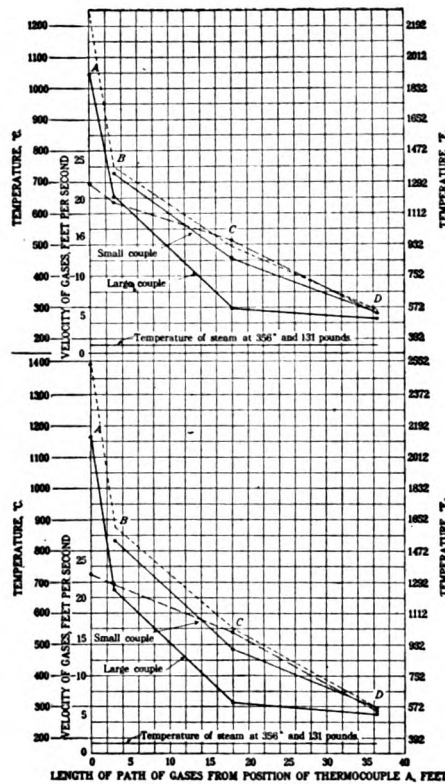


Fig. 7.

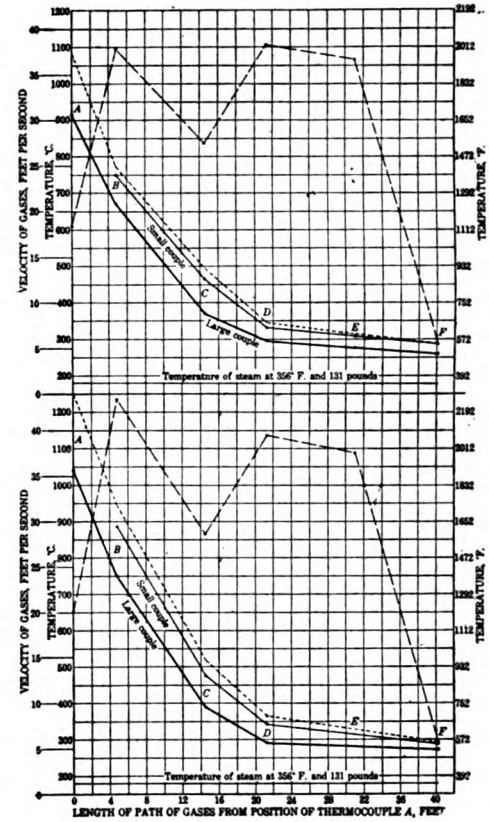


Fig. 8.

gas currents. This surging is very much the same as that of water falling over a dam. Fig. 5 illustrates these surges at points A and C. The surges at C have an amplitude of slightly over 50 degrees, while those at A have an amplitude of about 300 degrees. Anyone who has watched a bonfire located where the flames were sheltered from the wind, has noticed that there were continual flame surges. In fact a fairly good idea of flame surges may be obtained by watching a match burn when the flame is sheltered from all drafts. Another illustration of the surging of flames is the "singing flame" mentioned in all works on elementary physics. Any flame burning in an enclosure will be subject to certain periodic

have a tendency to mix the gases very completely as they pass upward.

The large amplitude of the temperature surges at A is probably due to the fact that this couple was at times immersed in the jet of ascending hot gases and at other times in the eddy of comparatively cool gases at this point. Another factor that is mentioned in the caption of the curve, is the formation of balls of chilled gases among the tubes. These balls of cool gas will have a tendency to drop into the lower portion of the setting, but will be sustained by the up-flowing current of hot gases. An analogous action is the submerged bubbles of air when a stream of water is falling into a body of water.

Another fact that is shown in Fig. 5 is that the temperatures at points A and C are those between which the dissociation of 2CO to C and CO_2 will occur as shown in the curve on page 234 of the May, 1919, issue. A con-

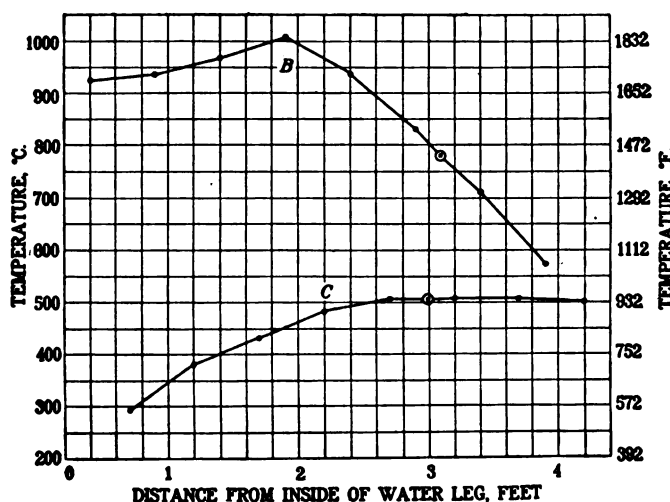


Fig. 9.

Curve showing variation in temperature at different distances from the inside of the water leg of a single pass horizontally baffled boiler. Solid fuel, underfeed stoker. These curves were obtained by moving the couples located at points B and C by 6-inch steps from a point 6 inches inside the water leg to a point 48 inches from the water leg. These curves illustrate the "hydraulic" flow of the hot gases forming a stream of high temperature gases below the lower surface of each baffle and cascading over the end of the baffle to the next higher level. The location of the high temperature points and the drop in these curves indicates the trajectory of the stream of gases due to its horizontal velocity in flowing off the end of the baffles.

siderable portion of the soot formed in this pass will drop into the pocket in the setting below the pass, other portions will pass on and out of the stack.

Figure 2 shows the stream of hot gases passing through a single pass horizontally baffled boiler. The location of pyrometer couples is indicated by letters and the curves in Figs. 7 and 9 have been plotted from the readings made. The point B on curve in Fig. 7 is 225 degrees lower than the peak of the curve in Fig. 9. In commenting upon Fig. 9 (Fig. 14, Bulletin 145) the bureau says: "Couple B showed a considerable range of temperature variation. The maximum temperature, which was at a point about two feet from the inside of the water leg, was 430 degrees C. higher than that at a point four feet from the water leg. This wide variation was undoubtedly caused by the position of the end of the lower baffle and the sudden turn of the gases. *It seems that immediately above the lower baffle there was a layer of comparatively inert gas which had a temperature much lower than that of the stream of moving gases.*" The italics are the writer's. It will be noted that the bureau attributes this correctly as a layer of cool gas is indicated in Fig. 2 immediately above the lower baffle. The drop in the curve C Fig. 9 is likewise due to this eddy of cooler gases. In this boiler, Fig. 2, the slope of the upper baffle is such that it will tend to increase the velocity of the stream of hot gases flowing immediately below it. Thus decreasing the thickness of the stream and increasing the thickness of the eddy of cooler gases below it.

It is to be regretted that the bureau did not make surge observations in this boiler setting as they would have been particularly interesting. This particular setting is an extremely good example of what should not

be done. In his book "Fours a Flamme," Prof. Groume-Grijmailo makes the following comment upon boiler settings: "The builders of boilers very rarely pay any attention whatsoever to the rational distribution of the hot gases. These defects are extremely common in the most recent designs of water tube boilers; this is the explanation of the numerous systems of bafflings and obstructions of the gas passages which are intended to distribute the hot gases in such a manner that they will bathe regularly and uniformly the tubes of the boiler. In reality it is not necessary to have any baffling or distributing walls. The hot gases will rise of their own accord and the heat will be regularly and uniformly distributed to all parts of the boiler." The setting designed by A. Bement is shown in Bureau of Mines Bulletin No. 40, Fig. 3, page 15. This setting comes the nearest to being in agreement with the flow conditions existing in a boiler set as recommended by the builder. Mr. Bement, however, has altogether too great an area in his first and last pass.

Fig. 4 shows the gas flow in a two-pass horizontally-baffled boiler. This design of baffling is better than the single pass. The gas velocities computed by the Bureau of Mines are much higher, see curve Fig. 8 than those of the single pass boiler. In reality the gain in this boiler is due to the longer path of the gases in contact with the tubes, but it is extremely doubtful as to whether the gas velocity is any higher than in the single pass boiler. Fig. 10 shows curves of temperatures made by locating the thermocouples at different distances from the water legs. The drops in curves D and C indicate the same pockets of cooler gas which occurred in the single pass setting. While the regularity of the curve E would seem to show that this couple had not at any time come in contact with the stream of hot gases.

The location of the last thermocouple in all of these tests, seems to the writer, to cast some doubt as to whether it really showed the temperature of the stream of hot gases leaving the boiler. This stream of ascending gas would have a fairly high velocity due entirely to its

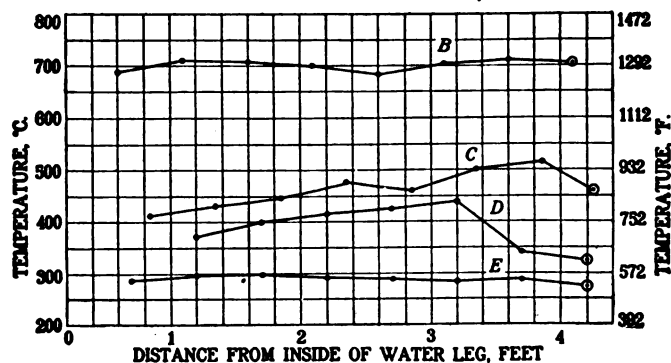


Fig. 10.

Curves showing the temperature at points at different distances inside of the water legs of the boiler as indicated in Fig. 4, showing two-pass horizontally baffled boiler. The flatness or lack of variation in curves B and E indicates that one of these was located in a chilled gas pocket and the other in a stream of hot gases. Curve C indicates that the points furthest from the water leg were just on the edge of the stream of hot gas flowing below the baffle. The drop toward the water leg shows an eddy of cooler gas at this point. The drop in D furthest from the water leg shows the cool gas pocket formed above the baffle.

temperature and it is extremely unlikely that it filled the full area of the gas uptake, being surrounded by a layer of relatively cooler gases.

Metallurgical Considerations of Duplexing

Description of Open Hearth Process—Suggestion for Removal of Sulphur and Phosphorus—Duplex Steel Equal or Better Than Other Processes if Oxygen Is Kept Out of Finished Product.

By **RICHARD S. McCAFFERY**

Professor of Metallurgy, University of Wisconsin.

PART II.

In the first part of this article in last month's issue was described the Bessemer stage of the American duplex process, in which the blast furnace iron was taken to mixers, thence drawn to acid lined converters and there desiliconized and decarburized. On the completion of this Bessemer stage of the process, the blown metal was carried by ladles to the open hearth furnace, the slag from the acid Bessemer process being first removed, sometimes by pouring it from the top of the ladle and sometimes by teeming the first ladle into a second ladle.

In the new duplex plants in the United States the open hearth furnaces are all of the tilting type and are of large capacity, usually of about 200 tons, which means a hearth area of 13 or 14 feet in width to 40 or 45 feet in length. The tilting mechanism is so arranged that the furnace rotates about its own center, thus keeping the ports in line so that fuel may be burned even while the furnace is tilted. The range of tilting is about 35 degrees on the pouring side of the furnace and about 15 degrees on the charging side. The fuel employed is producer gas, or if the plant is situated near a by-product coking plant, the tar from the latter may be very advantageously employed instead of the gas fuel. The checkers are usually of larger than average volume per ton and in the newer constructions the top of the checker work is kept well below the bottom of the charging floor so that working conditions in the hot summer months are more bearable. The tilting is done by a motor drive and worm wheel, and the rockers on each end are power driven and coupled together. The two doors on either side of the center door are provided with spouts so that the outpouring slag is conducted through holes in the charge floors, next the furnace and beneath the spouts, into slag pots or thimbles down below. In the newer furnaces the clearances between the moving and fixed furnace parts at the ports are reduced to a minimum to prevent the admission of air so far as possible. After a furnace has been tapped from the previous heat, it is turned up. The entire metal contents have not been poured but about one-half is kept in the furnace so that a 200-ton furnace when turned up after pouring its heat would contain about 100 tons of molten steel. The furnace men then begin the repairs to the side walls where the corrosion has been most rapid at the slag line, throwing the basic material into the far side of the furnace directly with the shovel and handling it on the near side by means of a spoon. When the sides have been thus repaired, calcined lime-stone or lime, and iron ore is charged into the furnace;

the flame turned on, this charge is melted down and a basic oxidizing slag is formed. Orders are now given to the Bessemer department for the number of vessels required for the heat, and, as blown, the Bessemer metal is cleaned of its silicious slag and poured into the open hearth furnace until it is nearly filled up. The last Bessemer charge, the "kicker," is but partially blown so that it contains about 1 per cent of carbon and it is now brought over and poured into the open hearth along with the others. Immediately this carbon-bearing metal is introduced into the molten bath, the highly oxidizing conditions which prevail cause the elimination of carbon as carbon monoxide, this gas passing up through the molten metal and slag, producing a most violent boiling. As soon as the kicker is completely poured into the furnace, this boil has become very violent and the slag as a result increases in volume and pours out of the furnace doors provided with the spouts for its exit and falls into the slag thimbles below. While the charge is thus violently boiled in the presence of a very basic oxidizing slag, the phosphorus which it contains is oxidized almost immediately to anhydrous phosphorus acid, P_2O_5 , which combines with the lime present to form calcium phosphate, $(CaO)_4(P_2O_5)$, and the slag, which overflows through the center doors, contains a large amount of this phosphoric acid. This violent boiling continues for some minutes until the carbon is nearly burned out and during this time the increase of slag in volume by its admixture with gas bubbles causes it to flow out the furnace doors. The violence of the reaction then diminishes and the bath loses oxygen more slowly now until finally the metal becomes quiet. When this stage is reached, a sample of the metal is taken by introducing a spoon into the molten metal which spoon has been previously warmed and covered with hot slag, and rapidly drawing off a sample, which is poured into a mould, and as soon as it sets, the test piece is cooled in water and broken to examine the fracture.

On the appearance of this fracture, the condition of the bath is known and further steps to complete the heat are taken as this fracture test indicates. If the carbon be still too high, further ore addition may be made, or if too great a quantity of phosphorus still remains, it may be necessary to add further lime and work the heat down. At intervals the condition of the bath is noted and fracture tests taken until finally when the bath has assumed the proper composition, the heat is tapped. While the heat is being tapped into the teeming ladle, it is kept covered with a suffi-

cient amount of slag to protect the metal surface, but beyond this amount the remainder of the slag is kept within the furnace by tilting the furnace so that the tap hole is completely submerged and the furnace side dams back the slag floating on top. As soon as there is a layer of metal in the bottom of the ladle, the recarburizer and the ferro-manganese or spiegel iron are added to the ladle contents, and when the ladle is poured full of metal, the furnace is tilted back and the heat is thus completed.

From this description it will be seen that the most important reaction taking place in the open hearth furnace is the dephosphorizing reaction and to get the maximum dephosphorization, a very careful control of slag composition and of the furnace temperature is necessary. The reason of this is that while phosphorus and carbon both have an affinity for oxygen and will combine with it, the affinity of each for oxygen does not remain the same at different temperatures, the oxygen preferably going to the phosphorus at lower temperatures and going to the carbon at higher temperatures. In other words, it is perfectly possible to operate a furnace if the temperature is very high so that most of the carbon is burned out, before phosphorus has begun to oxidize to any very large extent; while on the other hand, if the temperature be maintained lower, the phosphorus will first oxidize and then the carbon will be eliminated. This latter method is by far the more preferable. To get the phosphorus out quickly and get the phosphate slag out of the furnace, it is necessary that the conditions be strongly oxidizing and the metal at this time must of necessity take up a rather liberal amount of oxygen, for otherwise the phosphorus would not be eliminated. If now the phosphorus be gotten out of the molten bath after the carbon, the bath will contain large amounts of dissolved or combined oxygen and will be very wild whereas if the phosphorus has been rapidly removed first, by the highly oxidizing conditions prevailing in the furnace and the operation carried on at a low temperature, then when the phosphorus is eliminated there is still carbon in the bath and this carbon will now combine with the oxygen and get rid of it, producing a metal that is very much more dead than in the first case. Of course it is not necessary at this point to go into the matter of the oxygen content of steel. It is one of the most detrimental substances that can be present in steel and every care must be taken to eliminate it and get the metal as dead as possible before casting. However, there may be a tendency here which ought to be checked. If the metal comes over from the Bessemer converters very hot, which may easily result when abnormal conditions are attained in the converters, and this extremely hot metal is poured into the open hearth, on the addition of the kicker, the temperature may be so high that although you get a good boil of the bath, it results most largely in carbon burning and the phosphorus is not properly gotten rid of, and even though this phosphorus may indicate its presence in the tests drawn from the heat at intervals and steps may be taken to eliminate it, still the necessity of eliminating this phosphorus at the last end of the operation and

its elimination being dependent on the prevalence of oxidizing conditions, makes it not unlikely that there may still be an improper amount of oxygen in the bath when the heat is poured.

Some of the conditions resulting in abnormally high temperatures in the Bessemer converters were described in the last issue, and if this very hot metal is taken to the duplex furnaces, it seems hardly possible that opening furnace doors and cutting off the flame can still reduce the temperature to that proper for dephosphorization when such large metal masses are handled as is done in American plants, but there may be a rather strong temptation to carry out this procedure to make tonnage, for if after the kicker is poured and the boil has quieted down, if hot metal is used, the furnace temperature is higher and there is less time and effort expended in bringing the furnace up to the proper temperature preparatory to casting. In the description of the open hearth practice, the dephosphorizing reaction was most emphasized because this dephosphorizing function is best carried out in a basic open hearth furnace, and while it is the most important reaction, from the necessities of the process there are some other reactions which modify somewhat the handling of the furnace. For example, after the boil has quieted down and a necessity has arisen for lime additions to the charge, the slag may become rather thick and it can be thinned down by the addition of comparatively small amounts of fluoride of calcium, Ca F or fluorspar; the addition of fluoride to the slag seems also to increase the power of the slag for removing sulphur. The removal of sulphur is somewhat an uncertain factor in most open hearth practice. The conditions favorable for its removal are high basicity of slag, very considerable reducing action, and high temperature. These conditions of high slag basicity and high temperature may well obtain toward the end of the open hearth heat, but it is rather improbable that there is then any reducing condition prevailing to any large extent. The addition of this calcium fluoride to the molten bath seems to assist in the absorption of sulphur by the slag. Exactly how this is done is not known, but Saniter in England has gotten good results in desulphurization with the addition of calcium chloride to the open hearth baths so that it would appear that a lime addition which contained an easily decomposed acid was more effective for desulphurization than lime itself. There are possibilities that there are other materials that could be used for additions to the molten bath that would do equally as well as fluorspar or calcium chloride, and it is possible that certain of them might be better than either of these two.

The whole open hearth stage of the duplex process is usually carried out very rapidly. It is in fact on account of this rapidity and the necessity of frequent taps that tilting furnaces are now always employed. If there were any delay from tap hole troubles in pouring a heat, it would make a larger tonnage difference than with the old straight open hearth furnaces, therefore it cannot be tolerated, for which reason the extra capital expense for the huge tilting furnaces is

(Continued on page 297.)

Modern Forge Plant for Ordnance Work

Erection and Operation of Forge Shop at Gary Plant of the American Bridge Company, Suitable for Various Types of Hollow and Solid Forgings, Both Rough and Machine Finished.

By C. J. WALKER.

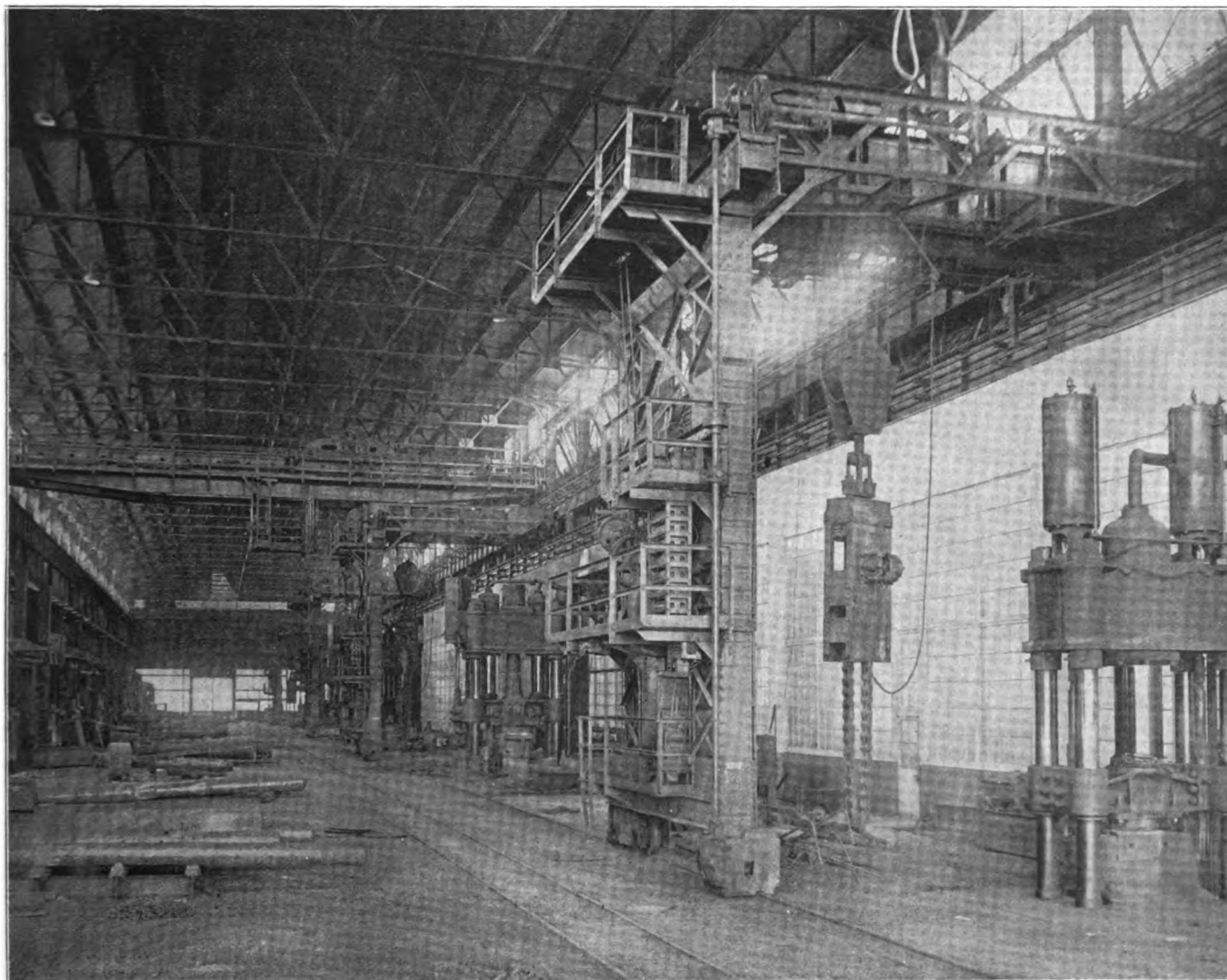
The American Bridge Company produced their first forgings in 1871, at the Chicago plant. From time to time since that date, plant enlargements have been made. The most important of these enlargements made necessary by the entrance of our country into the world war was at the Gary plant. We were called upon to produce forgings rough machined and heat-treated for the manufacture of 155 mm guns, 8-inch railway guns and 240 mm howitzers. This necessitated the erection of a forge shop, machine shop, heat-treating and annealing shops, chemical and physical laboratories.

Erection of the ordnance plant commenced early

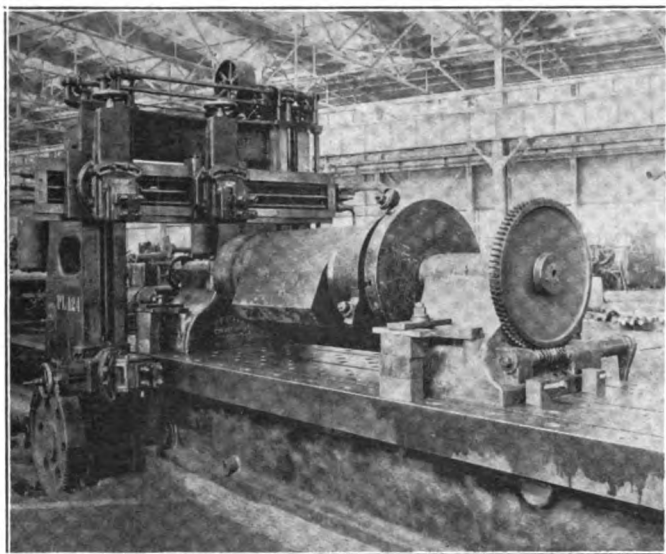
Paper read before May meeting of American Iron and Steel Institute.

in December, 1917. Less than three months later, namely, February 1, 1918, the forge building was practically completed, although the winter weather was exceedingly severe, unusually heavy snow storms greatly handicapping the work. Five months later, or April, 1918, steel work on all buildings was about 80 per cent completed and fires were burning in some of the heating furnaces in the forge shop. The end of July, or eight months from start of erection, all buildings were practically completed.

The forge heating equipment arranged along the west wall of the shop, consists of two-door coal fired furnaces, capable of taking ingots to 78 inch diameter. The coal for the furnaces is conveyed to the hoppers by a Robbins conveyor, and is fed to the furnaces by



General view of forge shop showing presses, cranes and heating furnaces.



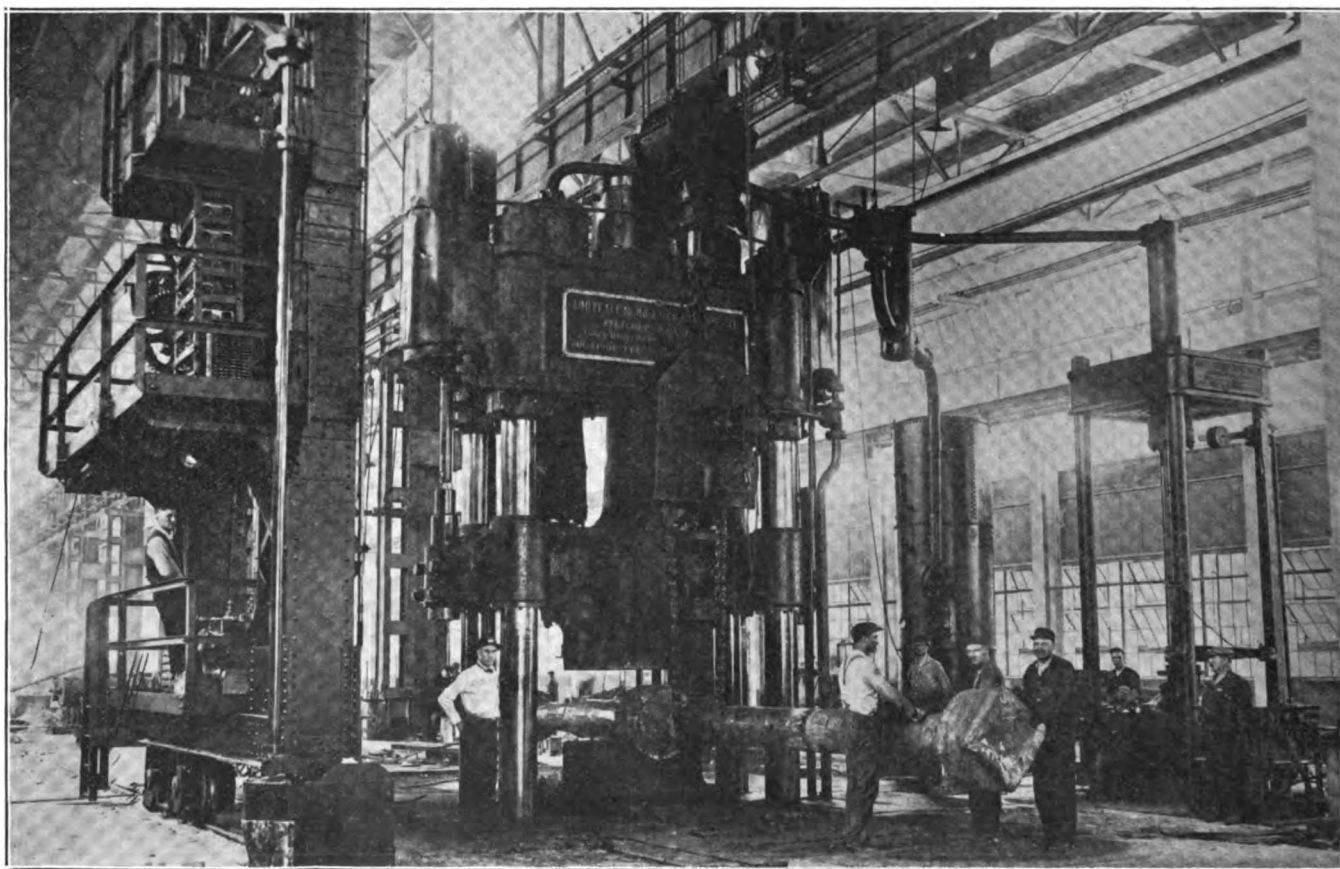
Planning 240 mm jacket.

means of underfeed stokers. Waste gas from each furnace passes through Wickes waste heat boilers, which generate steam for the presses.

The steam hydraulic press equipment, consisting of one 1,000-ton, two 2,000 ton and one 3,000 United Engineering high speed machines, is arranged along the east wall of the shop, each press being equipped with a single leg electrically operated gantry, complete with electric turning gear, running over top. Three electric cranes of 80 foot span operate above the gantries. The maximum weight of forging which

may be handled is 75 tons. Gun forgings were made from electric nickel steel obtained from the South Chicago Works of the Illinois Steel Company. The smaller forgings were made from blooms, while the larger ones were made from ingots which were received hot from the mill. Ingots were kept hot during transporting by means of special sand and asbestos lined cars. Upon arrival at the forge plant, the ingots were immediately charged into the heating furnaces.

The initial forging operation was performed on the 1,000 ton press April 24, 1918. The first gun forging consisting of one 155 mm tube was made May 6, 1918. The first of the 2,000-ton presses was placed in service May 15, 1918. The 3,000-ton press is an improved design for machines of this rating. The machine tool equipment consists of 33 turning lathes, 38 boring lathes, 18 planers, 2 slotters, 8 horizontal core drills, 5 test bar grinders, two 62-inch and one 90-inch cold saws, and a miscellaneous tool room equipment. The initial machine operations on gun tubes after centering, is turning. The forging is turned to about $\frac{1}{2}$ inch above finishing size and is then placed in the boring lathes where the boring is completed. This operation was performed by female operators in a very satisfactory manner. The outer surface of the jackets for the 240 mm howitzer and the 155 mm gun is made up of curved and planed portions on the same transverse section, and in order to plane these pieces they were mounted between rotating centers on bed planers.

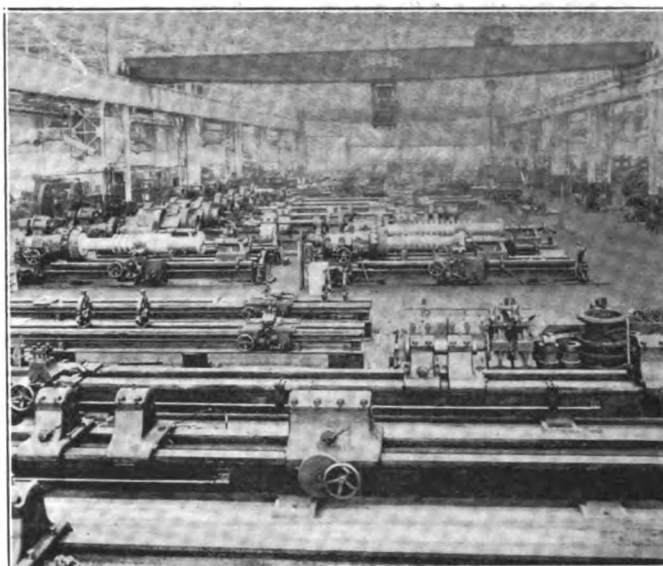


First forging being made in the 2,000 ton press.

The heat-treating building is served by one 15-ton crane, 40 feet from the floor, and one 50-ton crane, 75 feet from the floor. The heat-treating equipment consists of four vertical down-draught oil fire furnaces, varying in depth from 26 feet to 45 feet, and diameter 7 feet 10 inches and 9 feet 10 inches, with two quenching tanks, 26 feet deep by 19 feet diameter and 45 feet deep by 16 feet diameter, with a capacity of 120,000 gallons. The first gun forgings were heat-treated June 29, 1918. The annealing and drawing operations were performed in twelve 30 foot oil fire car bottom furnaces, eight of which may readily be converted to four 60 foot furnaces. All furnaces were supplied with a complete equipment of Leeds & Northrup recording and indicating pyrometers.

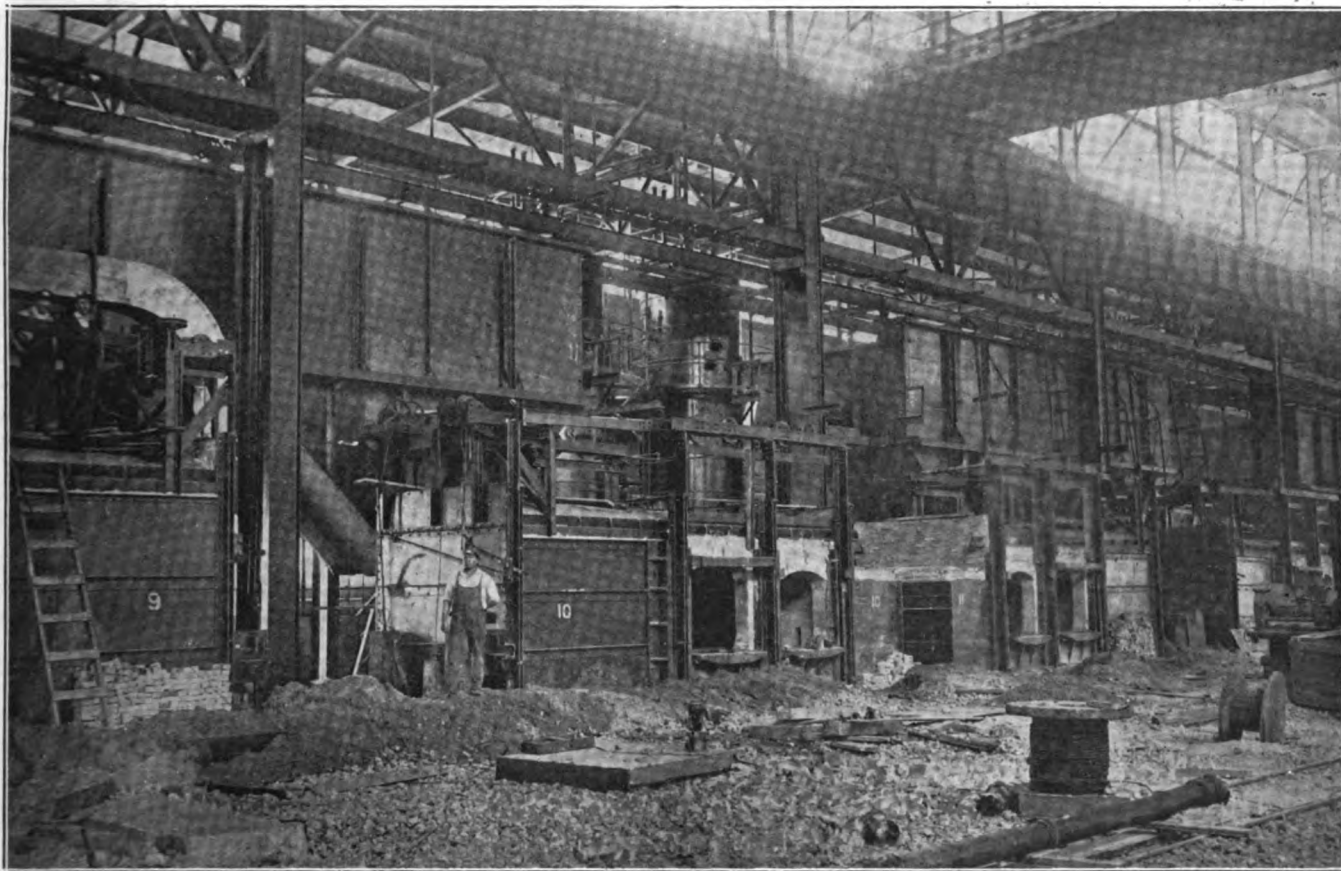
The cutting of test bars from the treated material was done with special tools and equipment, designed and built at the Gary plant, which made possible a feeding rate of $\frac{1}{2}$ inch per minute. The special features of this equipment was a small six-lipped high-speed cutter attached to a hollow boring bar, through which high pressure air and lubricant was admitted. The high pressure air completely removed all chips, thereby preventing the breakage of tools and making possible the use of a rapid feed.

Another tool of considerable interest developed at this plant, is a live center boring head with which it was possible to remove 700 pounds of chips per hour from a 9-inch diameter hole. The critical part of ordinary boring heads is the point of the tool. This point instead of cutting the metal, actually removes



Machine shop No. 3.

same by scraping. With the live center head, the metal at this point is removed efficiently by a 3-inch drill running at the proper speed. The factor therefore, which determines the feed to be used in drilling large diameter holes depends largely upon the removal of the metal at the center. With the live-center drill it is customary to increase the number of cutters in the head, thereby maintaining the work done per cutter at about the same value as with the ordinary head.



Forge shop coal hoppers—The coal for the furnaces is conveyed to the hoppers and fed by means of underfeed stokers. Wicks waste heat boilers generating steam for the presses are seen in the center of the picture.

Continuous Pair or Bar Heating Furnace

Hagan-Allis Continuous Pair or Bar Heating Furnace Used for Light Jobbing Mill Work, Also in Sheet and Tin Mills—Hydraulic or Electric Charger Used.

The furnace shown on this page, known as the Allis patented continuous pair of bar heating furnace, is used chiefly in light jobbing mill practice, but it is also used extensively in modern sheet and tin mills. This type furnace is in operation at the Otis Steel Company, Wheeling Steel and Iron Company, Whitaker-Glessner Company, Bethlehem Steel Company, Sparrows Point, Md., Newport Rolling Mill Company,

drops from the heating grooves in any shape or form they may take. There is no piling required, and the bars are then drawn out of the furnace in the usual manner.

A heater is not required to operate this furnace and a number of plants use a "drag-out" instead of a heater. It is the practice to have one heater in charge of six to 12 mills.

By this method of carrying the bars through the furnace continuously, each square inch of every bar is subject to the same heat treatment. It is absolutely impossible to have any black spots or cold ends. With this type scaling is eliminated. A pickled bar can be

The article on this and the opposite page is the first of a series of articles which will describe and illustrate modern types of American heating furnaces and annealing furnaces. Beginning with this issue and continuing for the next 10 issues one particular type of furnace will be presented each month. Batch annealing, continuous heavy work, continuous light work, muffle annealing, forge, continuous billet, plate heating, forge, and continuous ingot furnaces will be described. This series is being published as a result of an insistent demand, from our readers, for information of this nature. When completed the entire series will comprise descriptions of practically every essential type of heating furnace and annealing furnace in use in this country.

Mansfield Sheet & Tin Plate Co., American Rolling Mill Company, Tata Iron and Steel Company, Calcutta, India.

With this type of furnace the bars are placed in the charging rack at rear of the furnace, and one heat is charged at a time. For charging this heat either a hydraulic or an electric charger is used. When a cooled heat is charged it advances the other heats already in the furnace forward, and the front heat

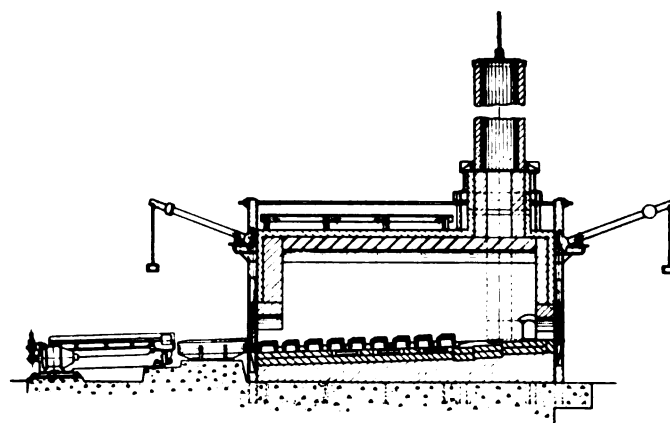


Fig. 2—Section through same furnace as below.

heated without any semblance of scale. The heating grooves are made of a special mix of material that has wonderful withstanding powers to resist heat, and the life of these bottoms runs from 15 months to two years.

The majority of these furnaces are stoker fired, and show records as low as 132 pounds of coal per ton of heated bars. These figures are based on stoker fired natural gas, and powdered coal. This furnace is handled by the Geo. J. Hagan Company, Pittsburgh, Pa.

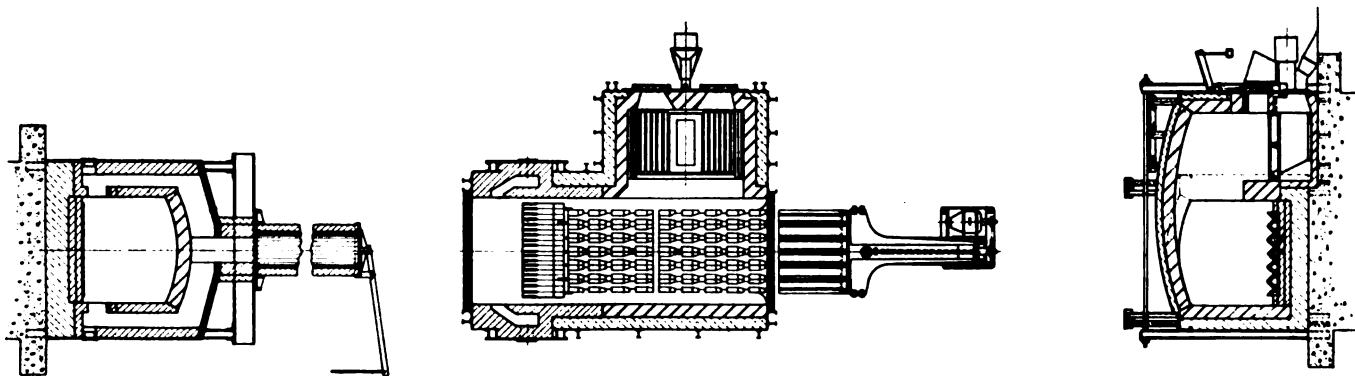


Fig. 1—General plan of patented Hagan-Allis continuous pair or bar heating furnace.

Continuous Annealing and Bluing Furnace

Hagan-Costello Continuous Open Annealing and Bluing Furnace for Plates or Sheets—Labor Saving and Uniform Heating Important Features—Refractory Rolls Convey Material in Furnace.

The Costello patented continuous open annealing and bluing furnace is designed to handle any commercial plate or sheet that requires open annealing or which is to be finished into blue stock. A number of furnaces of this type have been erected in this country and are in use at the Otis Steel Company, the Canton Sheet Steel Company, the Trumbull Steel Company, the Brier Hill Steel Company, Newport Rolling Mill Company, etc.

Plan, elevation and sectional views of this type of furnace are shown on this page. The main dimensions such as length and width are of course variable and therefore not shown, inasmuch as the furnace may be designed to suit particular conditions required for a specific purpose. The length and width of the furnace is determined by the tonnage requirement and

A feature of this furnace is the labor saving which can be effected. The type of furnace herewith illustrated requires only two men to enter the plate into the furnace. It is then taken up by the rolls and conveyed by the rollers in the interior of the furnace, at the proper speed to heat the plate at a uniform temperature. A set of pinch rolls are provided at the exit end for discharge of plate. The passage of the plate is along a horizontal plane instead of traveling on a sloping bottom.

By the use of this type furnace one of the old type furnaces is thus entirely eliminated as one furnace can be designed to take care of the entire output of any jobbing mill or plate mill.

Figure 1 shows a longitudinal sectional view of the Costello patented continuous annealing furnace. Figure 2 shows a plan view, in the center, and sectional views at the right and left.

The rolls conveying the materials through are refractory rolls built up with cast steel discs and refractory materials surrounding an extra heavy pipe. This pipe is insulated between the refractory materials and the discs holding the refractories in place, are in turn held in place by a loose key seat. A sleeve placed over the pipe at each end extends through the brick work or side walls of furnace, and in turn is held in place by a spring which takes care of expansion of contraction. The extra heavy pipe, which acts as a shaft extends through the side walls of the furnace to the bearings, which are supported on foundations on the outside of the furnace. The motor governing the power and speed is of the variable speed reversing type. The extra heavy shaft supporting the roll is water cooled. This water is used only for maintaining the strength of the shaft.

This furnace is handled by the Geo. J. Hagan Company, Pittsburgh, Pa.

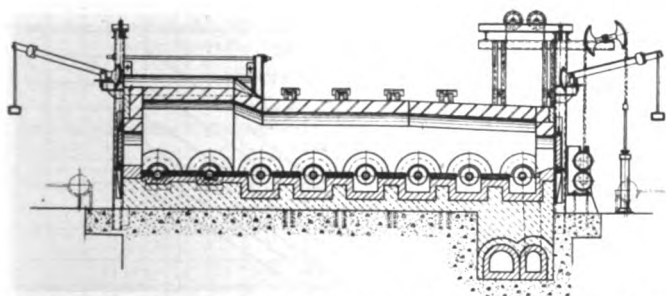


Fig. 1—Same furnace as below showing arrangement of rolls for conveying material through furnace, discharging, etc.

the diameter of the rolls depends upon the size of the stock to be handled.

Various kinds of fuel may be used. At present, furnaces are operating on producer gas, natural gas, coke oven gas, powdered coal and coal fired by stokers. Based on stoker practice, records show that the fuel consumption on this type of furnace is 45 pounds of coal per ton of product.

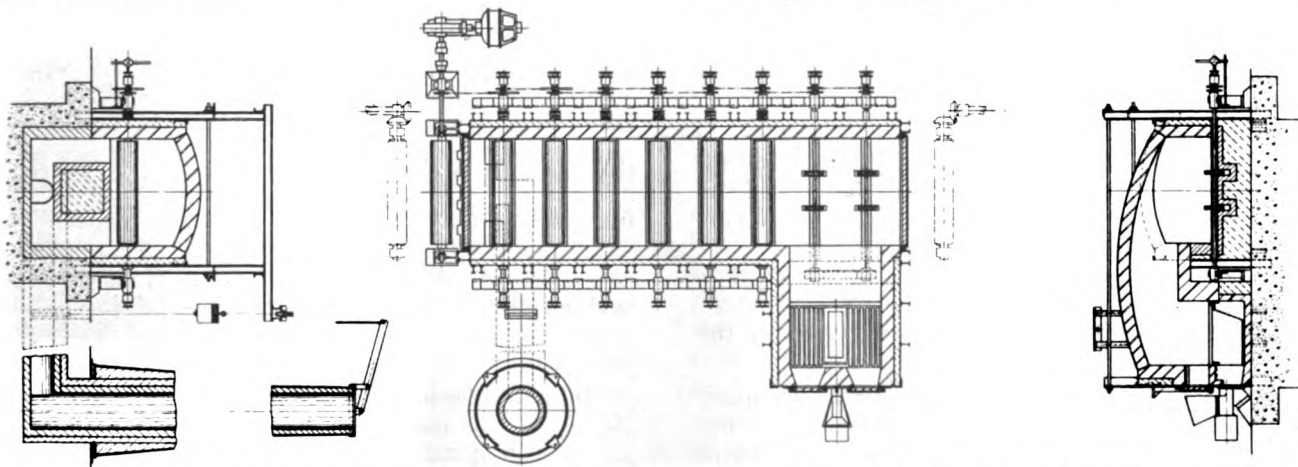


Fig. 2—Plain and sectional view of Hagan-Costello continuous annealing and bluing furnace.

Heating Furnaces and Annealing Furnaces

Reducing the Fuel Consumption Per Unit Weight of Steel for Heating or Annealing—Three Methods for Utilizing the Heat Content of the Flue Gases.

By W. TRINKS.

PART VI.

In former issues mention was made of the inherent lack of fuel efficiency of simple furnaces, and a rough numerical analysis of the various losses was given.

In the present and in the following chapters the means will be discussed by which fuel consumption per unit weight of steel (heated or annealed) can be reduced.

Briefly reviewed, the sources of loss were:

1. Heat in the flue gases.
2. Incomplete combustion.
3. Excess air.
4. Heat losses through walls.

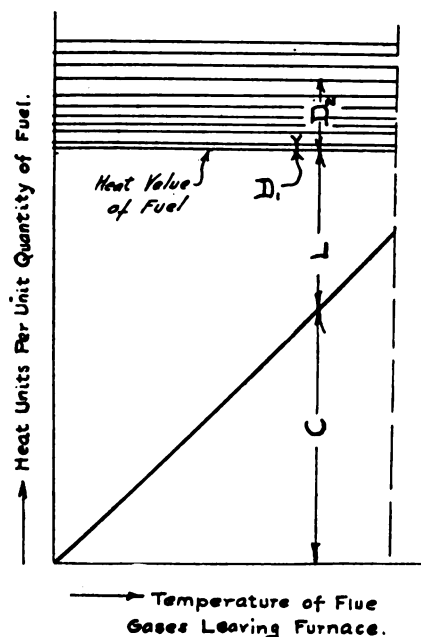


Fig. 39.

5. Radiation through openings.
6. Useless heat storage in receptacles (including furnaces proper).

The heat loss in the flue gases is so great that its reduction has received the attention of furnace designers to a considerable extent. The heat contents of the flue gases have been utilized in three different ways:

1. For preheating air for combustion.
2. For preheating cold steel.
3. For raising steam in waste heat boilers.

The three methods will now be discussed in the order mentioned.

In the preheating of air for combustion, two questions stand out prominently. One of them is: What amount of fuel can be saved by a given temperature of preheat? While the second is: What equipment

is necessary to secure the desired temperature of preheat?

For an answer to the first question turn to figure 39. In that diagram the following quantities were plotted (all referred to unit quantity of fuel).

C = heat in flue gases, including 5 per cent excess air.

L = heat going to steel, to the walls, lost by radiation and convection, heat going to cooling water.

D = heat in 1.05 times the minimum quantity of air required for combustion.

Let the actual quantity of heat which is required for heating steel, walls, for radiation and convection,

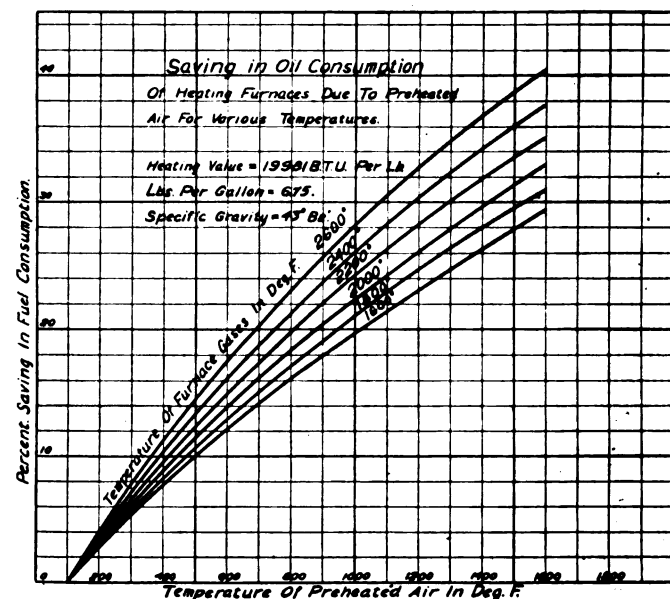


Fig. 40.

equal H. Then the quantity of fuel which is required

with small or no preheat equals $\frac{H}{L + D_1}$, and the

fuel which is required with D_2 (Btu per unit of quantity of fuel) preheat equals $\frac{H}{L + D_2}$. The relative

fuel saving (saving divided by quantity used before

saving) then = $\frac{\frac{H}{L + D_1} - \frac{H}{L + D_2}}{\frac{H}{L + D_1}} = \frac{D_2 - D_1}{L + D_2}$

It should be noted that D, the heat in the preheated air, can never exceed the value of C, if preheating is accomplished by the flue gases only. If, however, preheating is partly effected by heat otherwise lost

through the walls, matters are different. In that case, D can exceed C, and, in an ideal case, would do so by the amount picked up from the walls.

The fuel saving which is indicated by the above given formula was calculated numerically for fuel oil, coal, and for producer gas on the basis of the values given in figures 25, 30, and 31 (see part IV of this series). The results were plotted in figures 40, 41, and 42, based on 100° F. temperature of entering air. It is interesting to observe that the relative saving, for a given temperature of preheat, is greater for a high flue gas temperature than it is for a low flue gas temperature. At first thought this result may seem strange, because preheating of air to 800° F. by 1,600° F. flue gas appears to be worth more than preheated to 800° F. by 2,200° flue gases. But, in the latter case, the fuel consumption for a given heat requirement is so much greater, that the return of a given amount of heat per unit of quantity of fuel amounts to a greater overall saving.

The curves show that a considerable saving of fuel is, indeed, effected, if air for combustion is preheated

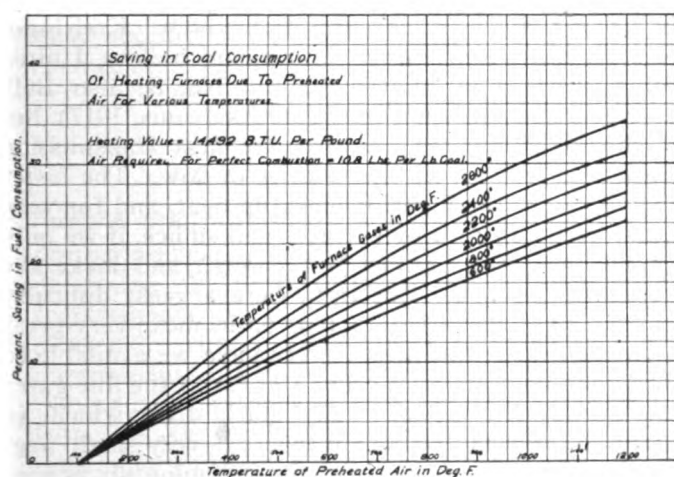


Fig. 41.

to high temperatures. And recognition of this fact leads to the second question: What equipment must be used to secure the desired preheat? As is well known, two ways are open. They are diagrammatically indicated in Figures 43 and 44.

In Fig. 43, fuel, air, and flue gases flow in a steady stream, each of them always following the same course. Heat is transferred through the wall A from the flue gas to the incoming air. The device is commonly known as a recuperator. In Fig. 44, fuel, air, and flue gases periodically reverse their direction of flow. Heat is alternately transmitted into walls B by the flue gases, and out of them to the incoming air. The device is known as a regenerator. Each of the two devices has certain limitations. Recuperators (Fig. 43) are very successful with low temperature flue gases, for instance in annealing furnaces and in continuous furnaces, because they can, in that case be made entirely of metal. For high temperature flue gases recuperators have up to the present time not been successful in the United States. They cannot be made of inexpensive metals, unless the temperature of

preheat is very low (500° to 600° F.) and they leak, if made of refractory material. The leak causes the incoming air to pass right into the stack, and the furnace "goes dead." In Europe, both in France and in Germany, certain designs which avoid leaks and certain methods for easily closing up leaks while a furnace is in operation, are claimed to be used, but they have not yet been successfully introduced in the United States. This statement is the result of a careful inquiry among the prominent builders and users of furnaces. A well known furnace engineer is convinced that the European designs would not be successful in the United States because we force our furnaces more than European engineers do, who are content to jog along at an even gait. Forcing means rapid changes of temperature, and, in consequence, develops leaks. Tile recuperators are quite satisfactory in furnaces in which the temperature remains practically constant,

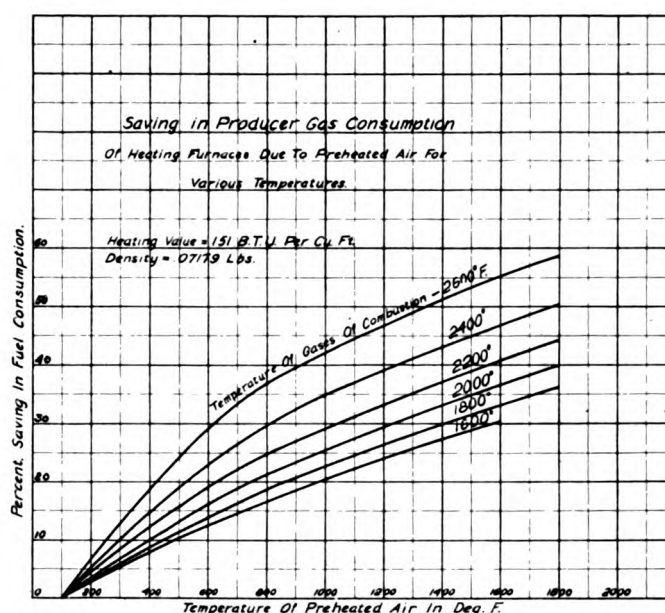


Fig. 42.

such as in gas retort furnaces and in zinc distillation furnaces.

Regenerators are, in a measure, free from leakage trouble, but not entirely so. They must be reversed, which action is accomplished by a valve V, (Fig. 44) or by a number of valves. If these valves leak, some air will pass directly to the stack and the furnace will be robbed. However, the heated checkers B act as stacks and assist in drawing air into the furnace. The result is that regenerators are at present the only device which is used in the United States to obtain high temperatures of preheat. The flow must be reversed quite frequently and, for best results, quite regularly. But that work requires watchfulness on the part of the operator and distracts his attention from other work, which is particularly undesirable with small furnaces in the working of which one man does both the heating of the metal and the shaping of the heated metal.

In all engineering problems the question is: What must be the size of the equipment to produce the desired result?

Applied to the present problem that question reads: What must be the size of the heat exchanger (recuperator or regenerator), to give the incoming air the desired preheat, for a given furnace? For the purpose of an answer let us write the elementary equation of heat transmission, referring to the recuperator, Fig. 43. $(Dt) kA = W (\text{Integral}) c (t_f - t_i) = W'c' (t'_i - t'_f)$.

In this equation, which is based on heat transmission by convection only, (Dt) is the average temperature difference between flue gas and air. (Dt) approximately equals $\frac{1}{2} (t'_i + t'_f) - \frac{1}{2} (t_i + t_f)$.

k is the coefficient of heat transmission, Btu/sq. ft., deg. F. and hour.

A is the heat transmitting surface, sq. ft.

W = weight of air flowing, lbs./hour.

W' = weight of flue gas flowing, lbs./hour.

c = specific heat at constant pressure of air.

t'_f, t'_i are, respectively, final and initial temperatures of gas.

t_f, t_i are, respectively, final and initial temperatures of air.

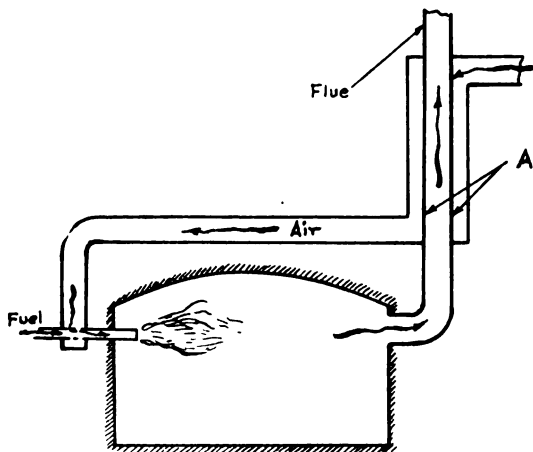


Fig. 43.

The problem is to solve for A . The solution would be easy if k (the coefficient of heat transmission) were constant. But, unfortunately for a simple solution, k is not constant. Rather, it may be equated to $k = k' + k'' \times d \times v^*$, where k' and k'' are constants and

*Note—Metallurgists seem to prefer the form $k = k' + k'' \sqrt{v}$

while mechanical engineers commonly use the form $k = k' + k'' d v$. At high temperatures probably neither one is rational, because radiation is neglected. But the latter varies with the amount of dust carried in the air and with the salt vapors carried in the flame. For low temperatures the straight line formula is absolutely correct, as I have found from many different tests. For high temperatures, really reliable test data are very scarce, but test data of my own indicate that the straight line law is more nearly correct than the square root law. Arrangements are now being made to secure better data on heat transmission coefficients in the Mechanical Engineering laboratories of the Carnegie Institute of Technology.

The expression $k = k' + k'' \sqrt{v}$ neglects the effect of the density, which effect is very marked. Nicholson (Manchester) gives (for gas to metal) $k = \text{density (lb./cu ft) velocity (ft/sec), neglecting the constant factor. My own experience indicates that } k \text{ (for strictly non-radiating gases) } = 1.5 + 4 \times \text{density} \times \text{velocity. Bell (Proceedings of the Engineers Society of Western Pennsylvania) gives } k = 2.1 + 2.25 \times \text{density} \times \text{velocity.}$

when d = density and v = velocity of the medium flowing along the wall A .

It is not desirable to review the complete theory

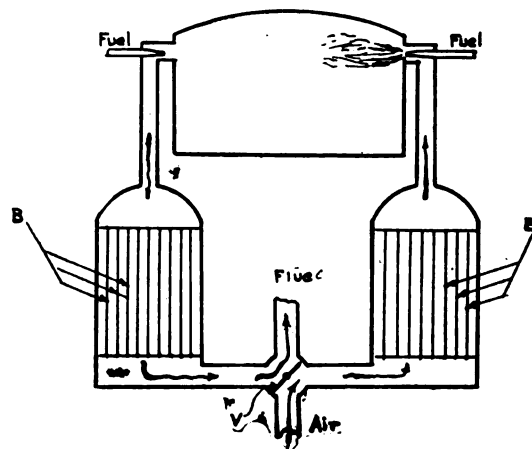


Fig. 44.

of heat transmission through walls in a monthly publication, particularly since the whole matter is contained in a paper which is accessible to anybody (Kreisinger & Ray, heat transmission into steam boilers, United States Bureau of Mines, Bulletin No. 8; also Bell, Engineers Society of Western Pennsylvania, 1917), but it should be pointed out that the heat transmission coefficient grows with the velocity of flow. The faster the air flows, the faster it picks up heat, and for very small heat transmitting surfaces will suffice, if we only let flue gas and air flow fast enough and make the path long enough. But right here a great difficulty arises. High velocities and long paths mean very great pressure drop. And what forces have we available to overcome such pressure drop? As far as the flue gases are concerned, we have only stack draft which, in portable and semi-portable furnaces is very small, negligibly small. And as far as the incoming air is concerned, we have frequently nothing but the draft which the injection of fuel into the furnace produces. In some cases a fan or a blower is available for moving the gases into the furnace.

Regenerators are usually located below the fur-

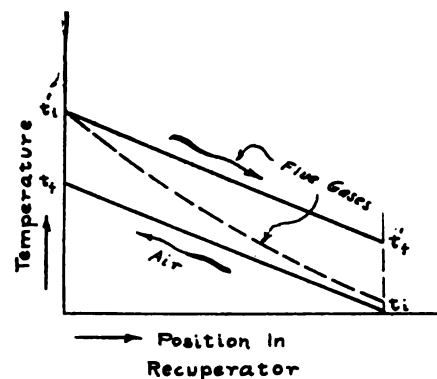


Fig. 45.

nace. In that case the checker chamber acts as a stack for moving the air up into the furnace.

In consequence of this limitation of the "fluidomo-

tive force" (a term which was coined by Prof. Rateau, of Paris) the velocities of flow are, for the vast majority of cases, held between rather narrow limits, and the coefficient k varies, for the general run of furnaces, between rather narrow limits. Likewise, air and gas density vary within narrow limits. From tests which I have made, and from tests made by others, k (from gas to air) ranges between 2.0 and 3.0 for furnaces with natural draft. While these values do not agree very closely with those given in the footnote, they are better applicable to ordinary furnace conditions in which, besides the nominal "heating surface" or heat transmitting surfaces, there is always additional surface which absorbs heat from the gases and radiates it to the heat transmitting surface, or vice versa. With these values a rough approximation of the heat transmitting area can be made in this manner:

Assume that all of the flue gas passes through the recuperator, and that conditions on the flue gas side are similar to those on the air side. Then the diagram

Fig. 45 will hold, and $\frac{W}{4}(t_r - t_i) = 2.5 A (t'_i - t_r)$,

where W = weight of air flowing, pounds per hour; $\frac{1}{4}$ = specific heat (roughly); 2.5 = heat transmission coefficient (Btu per sq. ft. per hour per deg. F.),

$$W(t_r - t_i)$$

and $A = \frac{W(t_r - t_i)}{10(t'_i - t_r)}$ sq. t'_i is known from the

furnace temperature; t_i is known; t_r is set by the desired preheat. If W is known, A can be found. To determine W , proceed as follows: Calculate heat requirements and fuel requirements of furnace as indicated in parts 2 and following. Calculate the air requirements and calculate the saving due to recuperation or regeneration. (The saving may also be taken from the curves in the present installment). The remainder equals the air requirement W to be used in the above given equation for A .

In making the calculations, or in testing furnaces with recuperators, it is frequently found that a larger area is needed than is calculated from the equation

$$A = \frac{W(t_r - t_i)}{10(t'_i - t_r)}$$

any can be attributed to insufficient flow of flue gas and to radiation from the recuperator. In many furnaces, (wholly or partly) burnt gases pass out through openings, particularly around the door. The flue gases then lose in temperature more rapidly than the air gains (see dotted line in Fig. 45), and the average heat transmitting temperature difference is less than $t'_i - t_r$, dropping down to a fraction of that value.

As before stated, the calculation in question is near enough for quick, approximate computations, particularly in view of the uncertainty which is brought in by the flue-gas escaping around the door.

In the next issue curves will be given for a more exact calculation.

METALLURGICAL CONSIDERATIONS OF DUPLEXING.

(Continued from page 258.)

justified. The ideal way for carrying out the open hearth stage of the duplex process would be to add just sufficient oxygen down to the last atom to combine with the phosphorus and that part of the carbon which it was desired to burn out, but not add one atom beyond this because then the chances are that this excess oxygen would dissolve in the molten bath. On the other hand the velocity of chemical reactions is dependent on the masses that are reacting, so that near the completion of the oxidation reaction, the velocity of this reaction slows down very appreciably and in fact becomes so slow that to make it move at all a greater amount of oxygen than is theoretically required is added of necessity. Otherwise the process would never attain completion. It is just this necessity of having this excess oxygen present to eliminate the last phosphorus and carbon that the danger comes in and care must be taken to in turn get rid of this oxygen so as to produce as far as practicable an oxygen-free-metal. How this can be done in the presence of an oxidizing slag, as the slag generally is, in the average duplexing open hearth, is rather difficult to see and suggests the possibility that it might be desirable to so operate the open hearth stage that the slag conditions were changed toward the end of the heat so that a reducing slag is formed instead of an oxidizing slag. This reducing slag would be extremely beneficial in sulphur elimination; it would certainly be beneficial in oxygen elimination; and for both of these reasons this seems to offer attractive possibilities.

One of the most important things so far as the open hearth stage of the duplex process is concerned, is to keep in mind that the order of elimination should be to remove phosphorus before all the carbon is gotten out of the bath, and as long as there is carbon that has to be worked off in the final stages, the chances of wild metal are considerably diminished. When there is nothing present to react with the dissolved oxygen of the bath after carbon and phosphorus are both eliminated, the bath will then contain dissolved oxygen to a greater extent than if the tapping point were approached with the metal containing no phosphorus but some carbon. It is of course much more important to look after this matter when making low carbon steels than those of higher carbon content, but if oxygen can be kept out of the finished product, there is no reason why duplex steel should not be equal to the best manufactured by other processes, or in fact be better than that produced in other ways.

Methods of Blast Furnace Charging

Various Conditions Which Must Be Met by Operators
in Handling of Present-Day Raw Materials So as to
Utilize Existing Charging Apparatus.

By A. J. MOHR,
Supt. Carrie Furnaces, Carnegie Steel Company.

During the early history of blast furnace operation the method of charging materials was a logical sequence of the other operating conditions. The furnaces were about 30 feet high, and lack of transportation facilities caused them to be located at the ore mines, preferably close to a hill, from which, due to their low height, a platform ran to the furnace top. At first, the quantities of ore, fuel and flux were not measured in any standard way, but were hauled in wagons to the furnace top, and shoveled in according to the individual ideas of the particular operator. Later, scales and hand barrows were installed, and the materials, after being dumped from the wagons, were shoveled into barrows and weighed before dumping into the furnace. The development from this period to the present day methods of handling and charging materials has been so comparatively recent that all present day operators are familiar with it. So long as raw materials maintained their early qualities of purity and excellence, the question of methods was not of such great importance. Later, however, next to the quality of the raw materials themselves, no more important developments in blast furnace design and operation were found than those dealing with the proper methods of charging raw materials.

The raw materials charged into a blast furnace are four, namely:

- (1) Iron bearing materials—Ore, cinder, scale, briquettes, etc., downcomer dust, scrap, sinter.
- (2) Fuel—Coke, anthracite, charcoal.
- (3) Flux—Limestone, dolomite.
- (4) Air.

The approximate quantities used per ton of iron produced are 4,300 pounds ore, 2,000 pounds coke, 1,000 pounds limestone, and 7,800 pounds air, when smelting Mesaba ores.

Method of Charging Air.

No other raw material has so little variance in the method of charging. Air supplied may vary in uniformity, due to temperature, moisture, and atmospheric pressure. Many blast furnace managers have found it to be of advantage to adjust the quantity of air supplied according to the existing conditions of temperature and pressure. This is done by adjusting the revolutions with the existing atmospheric conditions of temperature and barometric pressure, so that the actual pounds of air delivered to the furnace will remain constant. Efforts have also been made to eliminate the irregular flow of air as received from reciprocating blowers, by the use of turbo blowers. No general sentiment favors the turbo blower at

present; however, the uniform supply of air which they seek to attain is of importance, and their practicability as a blower should receive the attention of every operator.

The moisture in the air varies during the year as high as 10 grains per cubic foot, several different methods having been devised to eliminate this variation. These methods may be divided into three general classes—the dry cold, chemical, and those resorting to the use of cooling liquid in direct contact with the air.

The dry cold method consists of cooling the air to a sufficiently low temperature to condense the contained moisture. This method reduces the moisture to about two grains per cubic foot of air. The Gayley dry blast is the best known method of this type.

The chemical methods are nearly all based on the affinity of dry calcium chloride for moisture, and vary mainly in the methods of effecting the contact between the air and salt, the cooling of the salt, and its regeneration. Considerable heat is required in this method to regenerate the saturated calcium chloride.

The third method, that of using a cooling liquid, is a later development, and probably requires less cost of installation and operation than either of the others. In this method the air is washed by a cold brine, consisting of a calcium chloride solution, reducing the moisture to the point of saturation for the given temperature.

There is still another method of eliminating the variable amount of moisture in the air by adding steam to the air in the cold blast main in such quantities as to produce a moisture content in all cases close to the maximum amount that may be expected under weather conditions existing at the particular location. While this method does effect a uniformity in the condition of the air, it is hardly likely that much good is accomplished by introducing a uniform condition which is undoubtedly uniformly bad.

While the elimination of the moisture content of the air is of great benefit to the furnace, the methods so far devised are so costly in installation and operation that but few plants have adopted them, and it can be said that at present they are hardly to be found of any economic value, except under certain special conditions.

The composition of the air has received a great deal of attention, from a theoretical standpoint only, in consideration of the inert nitrogen content. Elimination of nitrogen, partially or otherwise, would decrease greatly the amount of work done by the blowing engines; it would also lessen the amount of heat required from the stoves; would intensify reactions in the fur-

Paper read before May meeting of the American Iron and Steel Institute.

nace hearth; reduce the amount of flue dust produced by reducing the volume, and, therefore, the velocity of the gases passing out of the furnace; increase the flame temperature of the gas, and decrease the amount of heat carried away by the stack gases of the stoves and boilers. However, while the nitrogen has been separated from the oxygen of the air in comparatively small quantities, the utilization of any present methods for the large volume of air required in furnace work is commercially impossible, and much remains for the scientist to accomplish before any of its benefits can be acquired by the operator.

The hot blast main and bustle pipe should be so designed and arranged as to insure a good distribution of air to the several tuyeres. A necessity to accomplish this is the use of clean gas, as dirty gas accumulates dust in the stove, which is carried over and deposited in the bustle pipe, obstructing the uniform flow of the air. In consideration of this possibility of unequal distribution of air to the tuyeres, a test was made at Carrie furnaces on No. 4 furnace to find if there was any appreciable difference in the amount of air passing through the tuyeres. At the time of the test this furnace had been in about three years, and as we use dirty gas in the stoves, the bustle pipe would have considerable dust deposited in it during this period. All the blow pipes, 12 in number, were replaced with pipes drilled and tapped and fitted up with pilot tubes. Ellison's differential gauges were used, with water as an indicating fluid.

The blow pipes and tuyeres were all of the same size, and were well cleaned. Rubber tubes were used to connect the pilot tube ends to the differential gauges, and we experienced considerable trouble with these burning off and having to be replaced, this condition causing us to lose the readings that are missing in the table. Readings were also taken throughout the test of the static pressures at each blow pipe. The results of the test are tabulated below. An arrangement of tuyeres, bustle pipe and hot blast connection is shown on Figure 1.

From a study of the results obtained it is seen that the amount of air passing through the tuyeres is fairly constant for each individual tuyere, but the different tuyeres vary considerably. Also, this variation has no uniformity whatever, but seems to be independent of any condition existing in the bustle pipe, or of the location of the hot blast main connection, which is between No. 4 and No. 5 tuyeres, as shown on sketch Figure 1. The static pressure of the different tuyeres is comparatively uniform, and, therefore, if the resistance inside the furnace was equal at all tuyeres it is evident that with the uniform static pressure obtaining, all tuyeres would receive approximately the same amount of air. Therefore, it is logical to assume that the reason for the great variation existing in the amount of air passing through each tuyere is that the resistance in the furnace is not at all uniform, but varies considerably for the different tuyeres. These conclusions lead us to believe that any irregularity existing in the distribution of the air passing into the furnace is a result of the furnace conditions only, and cannot be improved by changes in design or arrangement of the bustle pipe or hot blast main. It seems probable, therefore, that the proper method of distributing the air evenly is to so arrange the raw materials in the top of the furnace as to produce an equal resistance in front of all tuyeres upon their arrival in the hearth. To my knowledge, very little research has been done along these lines, but I hope these conditions will be investigated by the different operators, and some more definite conclusions arrived at which will be of value in eliminating a condition of irregularity that is not equalled in any of the other phases of charging.

The charging of these raw materials presents a rather complex problem, the importance of which cannot be overestimated, and is more complex and more important, the less uniform, the less regular, and the less desirable from any point of view, within physical or chemical composition these materials are, as such irregularities can, to some extent, be compensated for or counterbalanced through attention to the various

Differential Pressure at Tuyeres, Ins. H₂O

Time	1	2	3	4	5	6	7	8	9	10	11	12
2:00	...	20.8	18.5	...	16.0	...	11.5	18.5	15.0	21.0	17.0	...
2:10	...	21.0	17.5	...	17.0	...	9.0	18.0	14.5	20.0	15.5	...
2:20	10.5	20.5	17.0	...	17.5	...	8.5	16.5	14.0	18.5	19.0	...
2:30	11.0	21.0	17.0	...	17.0	...	8.0	17.5	14.0	20.0	16.0	...
2:35	10.0	20.5	16.5	...	17.0	...	7.0	17.0	15.5	21.0	...	...
2:45	10.7	19.0	17.0	...	16.5	...	7.5	17.0	15.0	20.5	...	...
3:00	9.5	19.0	16.9	...	16.0	...	7.0	16.6	14.0	16.6	...	...
3:05	10.0	19.3	16.7	...	16.4	...	7.9	17.0	15.0	19.9	14.3	...
3:10	9.6	19.5	17.3	...	16.1	13.5	8.2	17.2	14.3	19.2	10.3	...
3:15	8.2	18.8	16.3	...	16.5	13.2	8.5	16.6	15.0	20.2	12.2	...
3:20	...	21.5	19.0	15.0	17.0	16.0	9.0	17.5	15.0	22.0	12.5	...
3:30	...	...	...	...	...	...	9.0	18.0	16.0	21.0	11.5	...
3:35	...	19.8	17.5	10.3	16.2	13.0	9.0	17.5	16.0	21.5	15.0	...
3:40	10.5	19.9	18.0	9.7	16.7	13.5	...	...	...	...	...	...
3:45	8.9	19.6	16.9	8.0	16.2	13.1	8.9	18.0	15.5	22.0	14.5	...
3:50	...	...	...	...	...	...	9.5	17.0	15.0	20.0	13.5	...
3:55	9.3	18.8	17.1	7.7	16.7	12.1	10.0	17.2	14.9	20.1	14.2	...
4:00	11.8	19.1	17.2	7.4	16.2	12.5	9.5	17.2	15.0	19.9	15.2	...
4:05	...	...	...	...	...	...	9.5	17.3	15.4	17.1	15.3	...
4:10	...	...	...	...	...	...	9.2	16.9	14.0	17.1	11.5	...
4:15	...	...	...	...	...	...	10.1	17.9	15.6	18.8	15.9	...
4:20	...	...	...	...	...	...	9.2	17.3	15.2	18.3	...	...
Average	10.0	19.9	17.2	9.7	16.6	13.3	8.9	17.3	14.9	19.7	14.3	...
Calculated cubic feet air per minute passing through each tuyere:	2730	3860	3570	2700	3520	3140	2570	3570	3340	3830	3260	...
Average static pressure in pounds per square inch:	11.88	12.08	12.18	12.52	11.73	12.13	12.47	12.23	12.47	12.27	...	...

Generated on 2024-09-08 14:03 GMT / https://hdl.handle.net/2027/chi.096839463
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

details of the method of charging, both in engineering and in operating. This is so important that attention must be given the materials almost from the time they enter the blast furnace plant for proper grading and assorting.

The methods in use by the United States Steel Corporation at the ore mines and docks in grading and mixing the ore are of great value to the furnace operator, and minimize to a great extent the troubles of the operator in this respect. At the mines each car is analyzed before sending to the docks. At the docks the carloads are then distributed to the various bins, according to their analysis. Then the different carloads in the bins are thoroughly mixed in the process of handling into the boats, then to the receiving docks at the lower lakes, and lastly to the cars for their transportation to the furnaces. This method produces grades of ore which are remarkable in the uniformity

and the next cargo should be filled in between these piles; this operation also giving a good mixing to the various cargoes of the same ore and lessens chances of receiving ore of any great variation in filling the bins, either chemically or structurally.

The ores in the yard should be so arranged that those of very different chemical composition are not adjacent, but are separated by an ore whose analysis is approximately between the two, so that when the ore at the juncture of any two piles is reclaimed it will

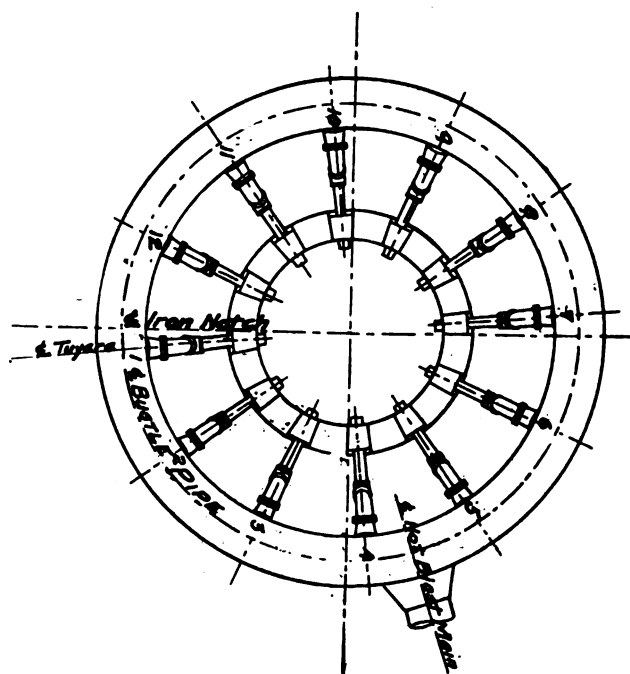


Fig. 1—Arrangement of tuyeres showing bustle pipe and hot blast main.

of their analysis, and for this reason invaluable to the furnace operator, producing a regularity of raw material which he could not hope to attain without such thorough dissemination of grades as they are shipped from the mines.

The Unloading of Ore and Flux.

The average furnace plant uses several different kinds of ores in its furnaces, and the method of stocking these in the yard should be an object of careful study to the operator. Different ores must be kept separate, and at the same time the full capacity of the stockyard must be utilized, so that it is necessary to observe closely the arrangement of the two different ores at their junction. This can be done by keeping the level of both piles as nearly the same as practicable, so that the coarse pieces of ore cannot run down the pile and across to the other ore. Also, in order to prevent segregation of the lumps, the ore should be stocked in small piles uniformly over the stock pile,

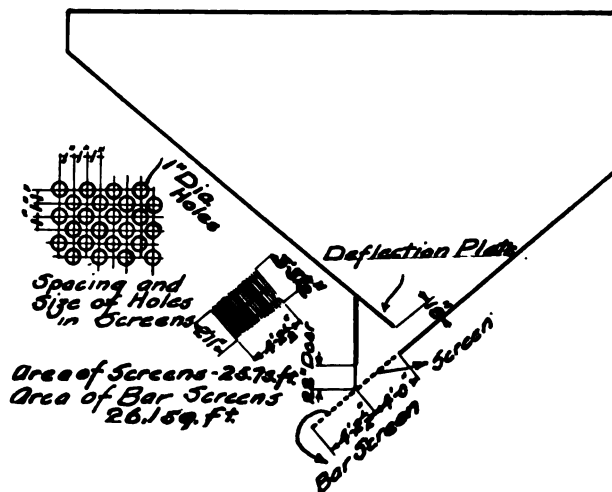
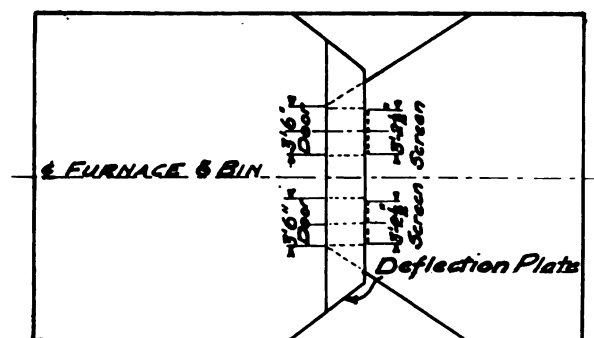


Fig. 2—Arrangement of bin and screens, Carrie furnaces Nos. 6 and 7.

not vary much in composition from the ore on either side.

For economy of handling, the stock pile should have ample capacity to eliminate handling ore from cars during the winter season. There is also another reason why this is desirable, because the frozen cars of ore are thawed either by means of steam pipes thrust in them or by burning fires under them. In either case the moisture content of the ores in the cars is changed considerably from the initial amount, and this will cause considerable variation in the actual weight of ore charged as compared with that already in the stock pile, consequently, when part of charge is taken from thawed ore and part from stocked ores, the variation in weight of the metallic contents caused by the different moisture contents, will produce irregular working of the furnace. Where limestone is stocked, similar precautions should be taken to prevent segregation of lumps.

There are many types of bins in use at the present time, the most common being the Brown, Hoover & Mason; Wellman-Seaver-Morgan, and the Baker. Most bins are equipped with mechanically operated doors, both steam and electrical operation. Some modern bins, however, still use hand operated doors. These bins have all been designed to eliminate as much as possible the sticking and arching of the ores in them. However, it is a difficult proposition to do this, and there is no ore bin, to my knowledge, which does not have to be dug out when it is necessary to utilize its full capacity, and in most plants constant attention must be given to the bin to insure that each door will be covered with ore, especially when weather conditions are bad.

The bins should be of ample capacity to supply the furnace for a considerable period in case of a breakdown on the ore bridge, and for reasons of economy the capacity should be sufficient to hold a 24-hour supply so it will be unnecessary to work the ore bridges at night. They should be located in relation to the furnaces so that the larrys will have the least possible length of travel.

The bin doors have a very special work to perform, and many cases of poor furnace practice are probably caused by the inability of this part of the ore handling machinery to perform its work in the proper manner. The human element comes in very strongly at this point, and for this reason every possible precaution should be taken by the operator, first, to see that the doors will do their work as well as is possible, and second, that the men perform their duty of weighing accurately. Much depends upon the design of the bin door to make it possible for the men to fill the larrys quickly and accurately, and too much time cannot be taken by the operator to attain this object. However, with the best of designs, the ore may occasionally come out of the door with a rush, and fill the larry considerably over the amount necessary. This condition must be met with such a layout of bins and larry cars that it is comparatively easy for the larry car operator to remove the excess amount. In regard to this point, I have seen, on some of the older installations, doors at the bottom of the larry cars from which it is necessary to remove any excess material, because the arrangement at the bin door made it practically impossible for the larryman to remove the material from the top of the larry. It is readily seen what would result if the lower part of the larry was filled with limestone, and the upper portion with ore, say 200 pounds in excess of the required weight; the larryman removes 200 pounds of limestone and goes ahead!

Limestone is generally stored in the same type bins as the ore, and causes little trouble in handling, because of its free running qualities.

Coke bins are generally separate from the ore bins, as there are different requirements necessary for their operation. Coke will travel freely over a much flatter slope than that necessary for the ore, so that the bins can be made comparatively flat and shallow. In order to mix the different cars of coke thoroughly, and thus eliminate the possibility of receiving different qualities of coke in different levels of the furnace, the bin should

have a capacity equal to several cars of coke, and coke in any part of the bin should travel freely, to guard against having dead places in the bin where coke will accumulate for a considerable period of time, and only be used when the bin contents are low. Such places generally accumulate considerable dust, and when this coke is put into the furnace it is liable to cause considerable trouble in the furnace operation.

The importance of screening the coke thoroughly cannot be overestimated, and the bin should be so arranged as to allow for extensive and well designed screens. Besides the bad influence of coke dust on furnace operation, due to its small size, it is much higher in ash and lower in fixed carbon than the average size coke. Comparative analyses taken of the coke dust and coke at Carrie furnaces shows a percentage of 21.5 ash and 74.26 fixed carbon in the coke dust as against 11.85 per cent ash and 83.26 per cent fixed carbon in the average coke.

Much careful experimenting is required to find out just where to stop with the screening of the coke so as not to waste pieces of coke that are all right, and at the same time to remove the dust that would be injurious to the furnace. The slope of the screens, the depth of the stream of coke, the size and arrangement of the holes in the use of plate screens, and the size and distance between bar screens must be determined in each particular case.

We made an experiment some time ago to determine, if possible, the injurious effect of small pieces of coke on the furnace operation. We screened the coke over plate screens with $1\frac{1}{4}$ -inch diameter holes, and then re-screened, by hand, the resulting breeze over $\frac{3}{4}$ -inch screens to remove the small particles. The breeze recovered was then charged into the furnace by partly filling the skip with the breeze and then adding the regular run of coke out of the bin. We started with a mixture of 16 per cent breeze and 84 per cent regular coke, and increased the breeze to 25 per cent of the charge. We continued with this amount on the furnace for four days, stopping at the end of that time because of the inability to keep up the supply of hand screened coke. The furnace showed good effects, became hot, and later carried an increased burden of about 7 per cent without any appearance of becoming cold. This experiment, while not extending over a very long period, satisfied me that much coke that is screened out could be used in the furnace without causing any harm, thus effecting considerable economy.

Insofar as my experience has been with coke screens, I prefer the cross bar type of screen, with bars from $\frac{5}{8}$ -inch to $\frac{7}{8}$ -inch diameter, and spaced so as to allow an opening of about $\frac{3}{4}$ -inch to $1\frac{1}{2}$ -inch between the bars; these conditions depending upon the size and quality of the individual coke to be screened. The screen should have an angle of about 35 to 45 degrees, and should be located outside of the bin door so as to be readily accessible for cleaning. This type of screen is very easily cleaned by running a coke fork along the bars, and this feature is an additional advantage of no mean importance over other types of screens. We have had these screens installed at furnaces No.

6 and 7 for several years, and they have screened the coke satisfactorily. The amount of dust screened per ton of coke used for the year 1918 was 89 pounds. An illustration of these screens and their arrangement is shown in Figure 2. At furnaces Nos. 1, 2, 3, 4 and 5, due to the design of the bins and chutes, we were unable to install the cross bar screens, but have put in plate screens inside the bin, the size and arrangement of holes being shown in Figure 3. It was found necessary to have considerable more area if plate screens were used than in the case of bar screens to produce an equal amount of screening. We also found at first that the coke was passing vertically down through the bin to the door, and screening out very little dust. This condition was remedied by placing a deflector plate in the bins, as shown in the illustration, which forced the coke to pass over the screen. This plate extends, as shown, to within 16 to 18 inches of the bin bottom, and causes the coke to pass over the screen in a wide layer, having a depth of a few inches. A poke hole was cut in the front of the bin, and, in case of the coke stopping up, it is a simple matter to poke it out. These plate screens in 1918 removed 93 pounds of coke dust per ton of coke used. Plate screens are very hard to keep clean, especially when placed inside the bin. These holes also clog up more readily than do bar screens, and for this reason must receive considerable more attention in their operation.

The disposal of the coke dust produced (amounting to about 120 tons per day), has been a difficult problem with us, the only use at present time being for covering the iron in the ladles, and as a bottom in the soaking pits at Homestead Steel Works, also under boilers, mixed with coal, this amounting to 60 per cent of the total. However, stokers and grates have been developed which will successfully burn the coke dust, and eventually all the dust produced will be burned under boilers, replacing a large amount of coal, and resulting in considerable economy, in fact I consider it a fallacy and a waste to burn raw coal under boilers in this advanced day of conservation.

We use the volume method of measuring coke at the Carrie furnaces, the arrangement of our coke bins being such that weighing coke in the larry car is impossible. When measuring different kinds of coke by the volume method, the weight of coke per skip will vary considerably, unless, as stated before, the bin is of such design as to mix the contents of the several cars in it, which will average the different cokes and probably produce as accurate results as the weighing method, which introduces the error of weighing moisture, a variable ranging from 1 to 10 per cent. The volume method has additional advantages in that it gives a constant volume of coke to the round, which helps to stabilize distribution conditions, and in case small dirty coke is encountered, tends to counteract the result by an increase in weight for the same volume. Also, considerable extra labor is required to handle the coke through the larry cars, and additional expense is sometimes incurred in charging the materials by the necessity of using a separate larry car for the coke.

Under the present conditions, the operator in the Pittsburgh district has to contend with coke from 14

to 20 different mines and ovens, some of the coke hand drawn and some machine drawn. These conditions produce considerable variation in the weight of coke per unit volume, and militates against the measuring by volume method. However, upon the advent of by-product coke from a single plant at all our furnaces, the present disadvantages of the volume method will lessen considerably, as then we will be using a very much more uniform coke as regards the weight per unit volume, and under these conditions the volume method will appear to be better than the weighing method, which will still have the handicap of variable moisture content to contend with.

Larry Cars.

One of the most important phases of the charging of raw materials is to properly weigh the several kinds of ore bearing materials and the flux in the larry cars before dumping into the skips, and also to so arrange the several materials that there will be a uniformity in their mixture which will be retained through the successive steps subsequent to their delivery in the furnaces, especially in regard to the prevention of the segregation of lumps.

As stated before, the arrangement of larry car and bin should be such as to enable the larryman to readily remove any excess amount of material. This is a most important feature, because it is impossible with any present type of bin door to weigh the material accurately and quickly at all times, and if the work of remedying any over-charge is hard to perform, it is certain that it will not be done, except under conditions of constant supervision, which is a practical impossibility. With the large amounts of material required by the modern blast furnace, the operation of weighing the materials must proceed rapidly, and the larry car must be designed to move at high rates of speed so little time may be lost in transporting the charges. At the skip pit the operation of the doors must be simple, reliable and fast, as a further aid in saving valuable time. There are several types of larry cars on the market with mechanically operated doors, and the advantage they have over hand operated doors is obvious.

Larry car scales present a large problem in themselves, the condition of operation with which they have to contend is severe, and much attention must be given by the operator to this particular mechanism. Recording scales have been installed on larry cars at many plants, and their adoption has undoubtedly been of great benefit to the operator. These scales are equipped with indicators, which are very convenient in showing the larryman how close he is to the required weight of material he is weighing, this being very much better than the method of judging the amount in the car by feeling the balance on the ordinary scale.

The arrangement of the materials in the larry car, to secure a good mixture, is an essential feature of good charging methods. However, the proper method is dependent upon the individual designs of larry cars and bin doors, and no arrangement can be given that would be suitable for all conditions, but each operator must determine the best method for his individual case.

At all but one of our furnaces we have four larry

buckets per furnace, and each bucket fills the same skip in the charge every round, the charge consisting of two ore, two coke, two ore and two coke. A characteristic charge is shown here as illustrating our method of filling the larry car buckets:

		Skip A	Skip B
No. 1 Buckets	Group No. 3.....	5,500	5,500
	Beaver	1,500	1,500
	D. C. Briquettes	1,000	1,000
Total		8,000	8,000
No. 2 Buckets	Group No. 4.....	2,500	2,500
	Group No. 7.....	2,500	2,500
	Limestone	3,000	3,000
Total		8,000	8,000

The total burden in this case is 26,000 pounds, with 6,000 pounds limestone, and an 11,200 pound coke unit. It is seen that the two skips will carry the same material in each phase of the ore charge, so that if there is any inequality in the mixture of the materials produced by skip A, it will be rectified by the following skip B. Also the amount of material in all buckets is equal, or as nearly so as practicable, this feature helping to establish uniformity in the distribution conditions at the top of the furnace.

As an additional precaution against the segregation of lumps, especially those of large size, we have placed guards against the skip chutes, which hold the lumps until they have been broken up. This also prevents such lumps reaching the receiving hopper on the furnace top where they might possibly stick the small bell, and thus interrupt the process of charging, or in any case might disarrange the distribution of the material by stopping the regular flow from the small bell in that particular sector in which they happen to be located. Also as a mater of safety, since we have introduced the guards the men do not have to go on top of furnace to remove lumps from small bell, a more or less dangerous proposition on account of the possibility of encountering gas or being caught in a slip.

It would be well at this time to state that the foregoing statements regarding larry cars do not apply in all cases to the Neeland type of charging. In this method, the larry car bucket is of a cylindrical shape, and fulfills the duties in turn of larry car, skip, hopper neck and small bell. With it, the mixing of the materials, the prevention of any segregation, and uniformity of their subsequent distribution on the main bell, depends entirely upon the method of filling the bucket. At first, this system had no method of insuring equal distribution of the materials, excepting that the bucket was filled alternately from opposite sides of the bins, thus balancing up the extreme irregularity that would have arisen from filling the bucket always on one side. In more recent years this system of filling has been improved by installing a rotating mechanism on the bucket car, which rotates the buckets continuously while charging, or rotates it through a definite angle after each charge, thus endeavoring to obtain an equal distribution of lumps and fines in every sector. While the Neeland type was one of the first mechanical top filling methods, and proved to be a success, the large majority of blast furnace plants have adopted the two skip system.

Skip Cars.
Skip cars may contribute considerably to the effort to gain uniformity in the arrangement of the materials in the furnace. In order to further prevent lumps from segregating, and insure good distribution, each individual operator must carefully determine the proper location of skip while dumping, the angle of tilt necessary, and the speed of dumping, which will best suit his conditions.
The skip should be designed to prevent ore sticking in it, and should be so constructed that in case, with the volume method of charging coke, it is wished to change the coke unit, the alteration will be simple to make. Figure No. 5 shows the method of using curved liner plates in the skips at Carrie Furnaces. Liner plate A is for the purpose of throwing the materials

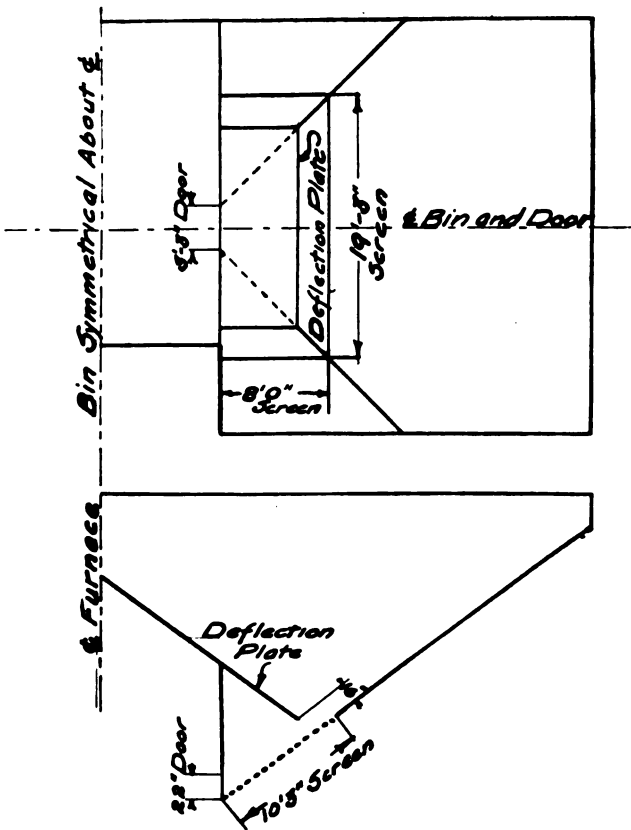


Fig. 3—Arrangement of bin and screens, Carrie furnaces Nos. 3 and 4.

toward the center line of the furnace, and we believe this feature is of good advantage in distributing the materials evenly in the receiving hopper neck. Liner plate B is for the purpose of preventing the materials, especially ore, from sticking to the skip.

Distributing Machinery on the Furnace Top.
The first mechanical system of charging, excepting the Neeland type, gave but little consideration to the proper distribution of materials. Later, however, the importance of this feature was realized, and many methods have since been devised to produce an equal distribution of the materials in the furnace. These may be divided into two classes—the stationary and the revolving top.
Mr. Vreeland's excellent paper on "The Distribution of Raw Materials in the Blast Furnace," read be-

fore this institute in 1916, gave an able discussion of the various types of tops in use, and the different methods by which they seek to attain the proper distribution of materials.

We use the stationary top on all our furnaces. The dumping rail of the skip incline swings in a radius about the center of the front wheel on the skip, allowing the skip nose to remain in the same location while dumping, which we believe insures better distribution of lumps and fines; also the skip nose is held back from the center line of furnace and allows the material to fall more nearly along that line.

The receiving hopper is made as steep as possible to prevent material sticking in it. The hopper neck is made sufficiently long, with its certain diameter, to insure it holding all of one skip; thus preventing materials from laying up on the side of the receiving hop-

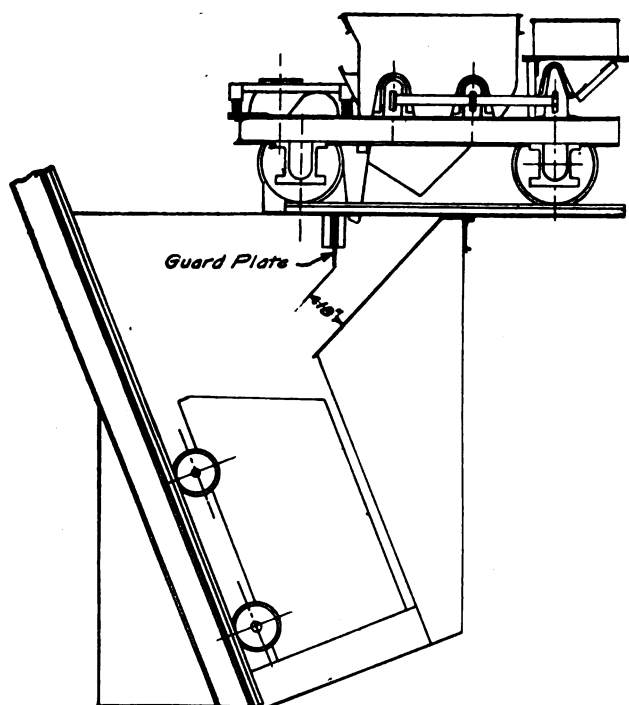


Fig. 4—General arrangement of larry car showing guard plate in stock chute.

per and following that side when the small bell is opened. The space between the small and main bells is sufficiently large to hold a full charge of four ore and four coke, with a coke unit ranging up to 14,000 pounds.

The main bell rod suspends from a series of links passing over a curved surface whose center is the main bell lever fulcrum. This eliminates side motion of the bell in its descent due to the radial action of the bell lever.

The bearing stands for both bell levers are designed so they may be moved in any direction. This enables us to move the bell levers if at any time the bells are not hanging central with the furnace. The main bell has a slope of 53 degrees to insure the materials sliding off freely, and the stock line is provided with a heavy cast iron protector, made in six sections, bolted together, having a wide base for resting on the brickwork. This type of top has given very good results

at Carrie Furnaces. All our furnaces are equipped with distributing machines of this general type, and the two oldest on the present linings, No. 3 and No. 4, have produced 996,856 and 1,028,128 tons respectively. Their individual performances over this period are:

	Furnace No. 3.	Furnace No. 4.
Average tonnage per day.....	494	495
Gross coke per ton pig.....	2.083	2.055
Coke screenings ton pig.....	66	69
Net coke per ton pig.....	2.017	1.986
Average loss.....	2.74	1.67
Average blast temperature.....	988°	1,013°

These tops have given very little trouble, and but a small amount of time has been lost on our furnaces due to repairs on the distributing machinery. Also, there has been no extraordinary repairs, such as renewal of the stock line, etc.

The modern revolving tops have proven satisfactory at a number of plants. However, I would not recommend that type of revolving top which is so designed that the distribution in the receiving hopper neck is admittedly uneven to begin with, and which seeks to eliminate this unevenness by rotating and discharging each skip load a fixed number of degrees in advance of the preceeding one, but rather would prefer a type giving fairly good distribution even in case it was not rotated. Such a type would, in my judgment, be much better, as the unequal distribution of the stock would be much less to begin with, and it therefore would have considerably more chance of attaining good distribution.

One of the most important improvements to the distributing machinery in recent years has been the electrical operation of the bells in conjunction with the skip hoist. Cables run from the bell levers to the hoist house, where the electrical mechanism is generally installed, and the bells are operated by means of these cables. The controls of the skips and bells are interlocking, and the bells can be made to operate in a predetermined sequence with the skips. By this means, a check is had upon the correct sequence of each charge; also the bells open at a fixed rate of speed, which cannot be obtained with steam cylinder operation. Another good feature of this method is the elimination of the possibility of having the small bell left open when the skip dumps, or prematurely opening the small bell, which would allow the materials to run out of the hopper neck on one side of the bell and thus be distributed very unevenly on the main bell.

We do not have electrically operated bells at Carrie Furnaces, but have installed a magnet at the lever of the small bell operating valve which prevents this lever being operated until the skip has been dumped, thereby eliminating one of the undesirable features of steam operated bells.

Even after attaining uniformity in the distribution of the materials on the large bell, the best results will still not be produced in the furnace until the proper method has been found of arranging the skip loads of coke and ore to produce the most intimate mixture. With the old range ores, good results were obtained by a system of filling which produced thick successive layers of coke and ore, but with the fine Mesaba ores

now in general use this practice has the effect of forming dense layers of ore through which the gases are no longer able to penetrate and do their work of reduction. This point is well covered by Mr. Vreeland's paper, from which I quote the following:

"With the results for the years 1902 to 1907 before us, during which period the percentage of fine Mesaba ores was on the increase, it is readily seen that our general blast furnace practice was going backward. Many changes were made in design, equipment and practice. Among other problems attacked, the question of filling received considerable attention. During that period the thick strata of materials were used quite extensively. Practice demands that a certain amount of ore must be deposited close to the furnace wall to prevent too much gas following this path. If the theory is correct that a more intimate mixture of the ore, coke and limestone would permit of a better reduction of the ore, because of the more intimate contact of the ore and the gas, due to the more uniform distribution of the gas, then the proposition resolves itself into the adoption of a system whereby we get the requisite amount of ore against the wall, and the remainder of the ore, coke and stone intimately mixed

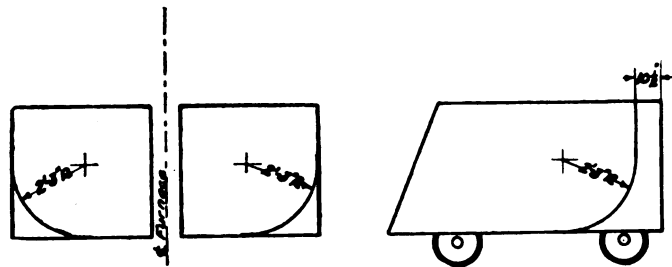


Fig. 5—Curved liner plates in skip car.

and uniformly distributed over the entire area.

"This system of charging was effected by filling and operating the bell as follows, assuming for illustration, a 15,000 pound coke charge:

7,500 pounds coke on large bell	Dump same into furnace
$\frac{1}{2}$ stone and $\frac{1}{2}$ ore bell	Dump same into furnace
7,500 pounds coke, $\frac{1}{2}$ stone and	
$\frac{1}{2}$ ore on large bell	Dump same into furnace

"The first section gives us a thin layer of coke practically uniform in thickness over the entire area of the furnace, with the ore and stone intimately mixed and deposited close to the walls, some of the lumps rolling towards the center. In the second section, the coke is placed on the large bell and the ore and stone intimately mixed on top of it; and, upon lowering the bell to deposit the charge, it is observed that only a small part of the coke leaves the bell before the ore and stone begin to break through and mix with the coke falling from the large bell into the furnace. As this section lies in the furnace, it is found that we have a very thorough mixture of ore, coke and stone throughout the entire layer."

With the same idea in mind as that explained by Mr. Vreeland, we changed from a system as follows:

4 skips coke on large bell	Dump same into furnace
4 skips ore and limestone on large bell	Dump same into furnace
To this system:	
2 skips ore on large bell	Dump same into furnace
2 skips coke on large bell	Dump some into furnace
2 skips ore and limestone on large bell	Dump same into furnace
2 skips coke on large bell	Dump same into furnace

At the time this change was made, June, 1915, all our furnaces were comparatively new, ranging from two weeks to two years on the lining. They had been giving us considerable trouble, due to slipping, making off grade iron, and high coke. Immediate results were obtained by this change in the filling; the furnaces became much more regular, the coke per ton of iron dropped, and slipping became a rare occurrence. This type of filling has been continued ever since on these furnaces, and has proved satisfactory at all times. A section through the charge lying on the large bell is shown in Fig. 6. This shows clearly the comparatively thin stratas of material produced by this method, and upon dumping into the furnace the layers are much

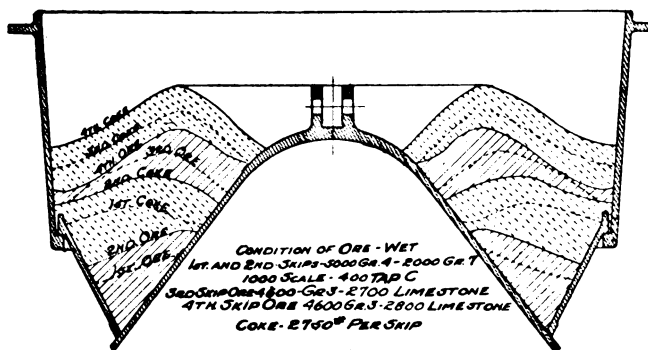


Fig. 6.

more intimately mixed than would be the case were they to be put in separately and allowed to follow their different lines of travel, in which case the coke would roll to the center of the furnace and the ore would remain comparatively near the walls. This would result in forming a central core of coke through which the gases would pass, causing excessive solution loss to the coke, and as a consequence the ores would reach the hearth in an unreduced condition.

From a study of the arrangement of the materials on the main bell, as shown by Fig. 6, it is evident that the thickness of the different strata depends directly on the size of the coke unit used, therefore, a reduction in the size of the coke unit will produce a reduction in the thickness of the different materials, and will result in a more intimate mixture upon their delivery into the furnace. Any attempts to realize this benefit must, however, take into account the capacity of the charging machinery to do the increased amount of work that will be necessary. In general, however, it is possible to obtain coke units of from 8,000 to 11,000 pounds, which, I believe, will insure a good mixing of the ore and coke, and result in better working of the furnace, than obtains with the large coke units of 14,000 to 16,000 pounds.

FOREIGN RELATIONS

PRESENT CONDITION OF BELGIAN INDUSTRIES AND MATERIALS NEEDED FOR RESUMPTION.

(Trade Commissioner Harry T. Collings, Brussels.)

The following report is based upon information supplied by the Comité Central Industriel de Belgique, the unofficial organization of the Belgian government which was charged with the collection of information regarding the destruction of property in Belgium by actual warfare or with the deliberate intention of crippling the country's industries. The information which this committee has collected shows innumerable cases of the destruction of industries. Sights such as those at La Louvière, at Charleroi, at Seraing, leave no doubt as to the industrial losses which Belgium suffered in the war.

German Seizure and Operation of Belgian Industries.

Some industries, however, have been spared. The interests of the invaders themselves induced them to respect, to a certain extent, the food industries (mills, sugar refineries, breweries, etc.), the public utilities (gas works, power houses, and water works), and the coal mines. Other enterprises were taken possession of and exploited to the profit of the enemy in spite of resistance by their owners and the workmen.

All these industries have, in the main, preserved their equipment and will be able to render valuable assistance in the work of economic reconstruction, provided they receive the necessary support.

Material and Labor Available for Manufacturing.

In their hasty retreat the Germans abandoned various quantities of all sorts of products, which, if rationally distributed under the system which is now being organized, may serve as a starting point for future manufacturing activities.

As to the labor situation, it must be pointed out that the working portion of the population was not diminished to anywhere near the extent it was in the great belligerent countries. The fact that compulsory military service was instituted in Belgium only three years before the war, and the impossibility of carrying out conscription levies because of the rapidity of the German occupation of the country, resulted in the majority of the men of military age remaining in Belgium. Many of the laboring class have suffered from privations which have temporarily undermined their health, and nearly all of them have been exposed for a long or short time to the demoralizing influence of enforced idleness. But, in general, the working population is still there, with its hereditary qualities, which training will rapidly revive. It is ready to return to work.

The information supplied by the above-mentioned committee will be taken up in the following order: Reorganization of Belgian industries, present manufacturing situation, and present requirements of raw materials.

The Reorganization of Belgian Industries.

Belgian industries have been divided into a well-organized system of 18 grand divisions.

In each of these divisions there have been formed one or more "groups" which take charge of the interests of each of the particular branches into which the industry in question is subdivided. Thus the glass industry comprises four groups—window glass, plate glass, cut glass, and bottling works. These groups are the essential feature of the entire system; they are not merely industrial associations, but they are judicial organizations, with authority to buy and sell. They were formed without any official intervention or con-

trol, but they have been virtually recognized by the government, in view of the cooperation which it gives them.

The Central Industrial Commission.

At the head of this system is the Central Industrial Commission, which existed before the war as a federation of the large industrial associations, and which has now established a "special reconstruction service," with headquarters at 11 Rue du Gentilhomme, Brussels. This special service is for the purpose of assuring unity of action among the various groups and to serve as an intermediary in dealing with the government—particularly the Ministry of Economic Affairs—in all questions of general interest.

Like the groups, the central industrial commission is not a government organization, but is absolutely independent. Moreover, its role is not, properly speaking, to solve problems, but to assist in their solution by the groups along uniform lines.

Contact with the groups is maintained by conferences, on fixed dates, with all the secretaries, and by the meetings of the "industrial delegation," at which the representatives of the 18 divisions of the industries above mentioned are present.

Present Manufacturing Situation—Mines and Quarries.

Actual warfare in Belgium caused much destruction, particularly south from Antwerp to Termonde and throughout West Flanders. In other parts of the country the destruction was largely wanton, the Germans having removed driving belts, copper, electric motors, and all tools, even when raw materials were not taken. So far as information can be obtained (the information of the committee closed January 20, 1919), the following gives a brief summary of conditions in each of the 18 divisions of the industries:

The coal mines which continued to work are intact, with the exception, naturally, of the abnormal wear and tear on equipment—notably the hoisting cables, which will call for immediate replacement. A great number of coke ovens have been left without fuel and have suffered confiscations of metal, baking apparatus, etc. Partial operations have, however, been resumed.

The porphyry quarries at Quenast and Lessines were occupied and exploited by the Germans after 1917. Some destruction of equipment occurred there at the time of the retreat, on the eve of the armistice, but in general the pits may resume work. The situation seems to be much the same in other quarries. The majority of the cement plants were exploited by the enemy, so that their equipment has not suffered except through careless operation and lack of repairs. The raw materials for this industry are available in Belgium. In the main, these plants may resume work as soon as transportation facilities are restored. Cement sacks necessary to the industry are obtainable.

Steel and Zinc Plants and Metal-Working Industries.

With the exception of two plants at Charleroi, which were requisitioned and placed under forced operation by the enemy, all the large steel plants have suffered considerable dismantling and destruction, which will entail prolonged idleness. The plants most seriously affected in this respect are probably those at Louvière, Marcinelle (near Charleroi), and Seraing. Others which have been partly spared can, for the present, resume the manufacture of certain products. The converter plants (i. e., those which have no blast-furnaces or tempering furnaces) appear on the whole, to have suffered to a less extent. Exact information furnished by the Iron and Steel Converter Group shows that at Liège at least a partial resumption of activity is possible in certain departments. The zinc industry has, on the whole,

suffered small loss of equipment, with the exception of the lead chambers of the roasting plants.

The metal working industries include shops for the manufacture of locomotives, cars, machines, copper plate, construction steel, electrical apparatus, automobiles, bolts and rivets, forges, iron, steel, and copper foundries—in short, everything connected with wrought metals.

The enemy was particularly destructive in regard to this industry, and there was no shop, however small, which was not deprived of its best machines, its leather belts, and the copper parts of its transmission system. In many cases the destruction extended even to the bases of the machines, which were demolished, and sometimes even to the foundations of the buildings. The localities of Morlanwelz, Nivelles, Charleroi, Manage, Le Roeulx, Louvain, Buysinghen, and many others present really deplorable examples.

A certain number of shops, especially those devoted to locomotive and car construction, were spared, the enemy taking them over and exploiting them for the needs of its railroads. They will be able to resume production as soon as supplied with the necessary raw materials.

1920 FOREIGN TRADE CONVENTION.

The Seventh National Foreign Trade Convention will be held in San Francisco, Cal., on May 12-15, 1920. It will be the first of these important conventions to be held on the Pacific coast, previous conventions having been held at Washington, D. C., New Orleans, St. Louis, Pittsburgh, Cincinnati and Chicago. In deciding on San Francisco for the convention city, the National Foreign Trade Council was influenced by the growing importance of the Pacific coast in the foreign commerce of the country, and by the enthusiastic support which the Far West has given all previous foreign trade gatherings.

Manufacturers from the East welcome the prospect of a San Francisco convention at which the problems of the "Twentieth Century Ocean" will be fully discussed. With many of the markets of Europe restricted by embargoes, it is natural for manufacturers to expand their trade in South America, and to look toward new fields among the great populations of China, Japan, India, Siberia, and Australasia. The importers of the country, both merchants and manufacturers, have a special interest in the trade of our western ports. Through them flow the nation's main supplies of vegetable oils, tea, rubber, silk, and tin, together with many manufactured articles of peculiar workmanship. Shipping men will find on the Pacific a marine situation of national interest, brought about by the development of a large Japanese merchant fleet aided by government subsidies and low labor costs. Traffic managers from the interior of the country will be enabled to see and judge at first hand the ports through which much of their sales will be routed in the future, especially if satisfactory export freight rates are obtained. Agricultural interests will be shown the possibilities of an increased trade in agricultural products with foreign nations, with special relation to the need for foreign outlets inevitably felt by large-scale intensive production of foodstuffs.

While the convention itself will be held in San Francisco, it will really be a Pacific coast gathering, and the cities of Seattle, Tacoma, Portland, and Los Angeles will share with San Francisco in the attention of the visiting delegates.

FOREIGN TRADE CORPORATIONS.

Indications are not wanting that American business men are progressing steadily in the organization of their forces for the development of foreign markets. At the annual meeting of the National Association of Manufacturers announcement was made that the first of a number of organizations to be formed under the auspices of that association had been incorporated. The name of this corporation, which is to develop the South American field, is Namusa South America Corporation. The word "Namusa" is formed of the initial letters of the corporate title of the National Association of Manufacturers of the United States of America. Similar "Namusa" corporations will be formed to trade with

other grand divisions. Announcement was also made last week of the formation of the American Foreign Trade Corporation, a \$20,000,000 concern, which will barter and trade with the Near East. A central operating base will be established at Constantinople and branches will be located in Armenia, Syria, and other territories which promise soon to be opened to world trade.—Guaranty Trust Company of New York.

GERMANY'S SHIPBUILDING DURING THE WAR.

(Excerpt from *Affarevarlden*; transmitted by Consul General Albert Halstead, Stockholm, Sweden.)

With regard to the most important economic problem after the war—that of bringing about a turnover in goods in order to fill the many gaps—Germany has been working hard to increase its tonnage. To what extent this shipbuilding has been going on cannot be exactly ascertained, as there are no building lists for the private docks, but some idea may be gained thereof by judging by their economical development, just as one by a comparison of the profit and loss accounts before and during the war can get an idea as to whether the undertaking has been profitable or not.

The Berlin *Tageblatt* has made many such investigations and states, among other things, that whereas Germany's shipbuilding in the year 1913-14 was in the hands of 18 companies, with a share-capital of 83,300,000 marks (the normal value of the mark is \$0.238), it is now carried on by 30 companies, with a capital of 163,600,000 marks, thus showing an increase of capital by 80,300,000 marks, or 96 per cent.

Of this increase 50,300,000 marks, or 63 per cent, was for new construction, and 30,000,000 marks, or 37 per cent, for increase of capital in the existing companies. During the time from the beginning of the century to the outbreak of the war six new shipbuilding companies were formed, with a capital of 14,300,000 marks, and the increase of capital during the same period was reckoned at 30,700,000 marks. This gives a total capital of 45,000,000 marks invested in the shipbuilding industry during the period, against 80,300,000 during the four years of war. In proportion to the present share capital the total reserve funds amount now to 21.09 per cent, against the former percentage of 15.96. The average profits amount now to 23.64 per cent of the construction capital, against a previous 6.93 per cent, and the shareholders' dividend is now on the average 9.77 per cent of the nominal capital, against a previous 4.7 per cent.

Of the 12 docks that were established in the years 1914-1918, no less than eight were established in 1918. The largest of these docks is Deutsche werft A. G., Hamburg, with a share capital of 10,000,000 marks.

CHROME ORE SITUATION IN SOUTH AFRICA.

(Consul William W. Masterson, Durban, Natal.)

The chrome ore supply is hampered considerably by the difficulty in getting it to the market over the railroads for want of cars, and some of the ore deposits are a considerable distance from any line of railroads, all of which limits its delivery at any given port. The deposits in this country are in the Transvaal and Rhodesia, and in the latter country is the largest chrome ore area with the highest percentage of chrome oxide.

The chrome ore of the Transvaal runs between 40 and 50 per cent chrome oxide, while there are certain deposits partially developed in Rhodesia, where the chrome oxide is over 60 per cent, making it about the richest chrome ore deposit in South Africa, if not in the world. As in nearly all mining ventures the industry is in the hands of what is called the chrome ore ring. This ring refuses to buy ore from any privately owned property, and the greater portion of the ore property in private hands is some distance from the railroads the richest deposits being some 25 or 30 miles distant, so it would seem that all the chrome ore deposits will eventually be absorbed by the ring, and unless some way can be found to develop these privately held properties, and markets found for their ore, the ring will absolutely control the chrome deposits in this country in a short time.

PRODUCTION TOPICS

STATICALLY INDETERMINATE STRUCTURES.

In recent years rectangular steel frames with riveted joints have been used, and many types of monolithic reinforced concrete frames have been developed. The use of statically indeterminate stresses cannot, accordingly, always be avoided. Structures are frequently made of an indeterminate type to secure economy of material. It is felt that analyses of statically indeterminate structures are desirable since such information will do much to inspire confidence in the reliability and in the economy of such structures.

An investigation of statically indeterminate structures has been conducted by the engineering experiment station of the University of Illinois to obtain a convenient method of analyzing the moments, stresses and deflections for a number of typical structures. The analyses were based upon the assumptions that the connections are perfectly rigid, that the length of a member of a rectangular frame is not changed by axial stress and that the shearing deformation is zero. The method used in the analyses and the equations derived are published in Bulletin 108 entitled, "Analysis of Statically Indeterminate Structures by the Slope Deflection Method," by W. M. Wilson, F. E. Richart and Camillo Weiss. The method has been explained in sufficient detail to enable the designing engineer to use it in the solution of his problems. It is believed that the fundamental principles presented may be readily coordinated with the ordinary principles of mechanics so that the more complex and even the simpler problems may be studied from a new viewpoint.

Copies of Bulletin 108 may be had without charge by addressing the Engineering Experiment Station, Urbana, Ill.

INDUSTRY PICKS UP.

The Matthew Addy Company's report of May 24, is of interest in that some interesting views are suggested. The report follows:

We are having a late spring this year. Farmers are having trouble getting their corn planted, and it has been a late, disagreeable spring in the iron business. However, since the beginning of the month things have been better. We estimate, from the reports of our own men, that the foundries are running somewhere between 50 and 65 per cent capacity. The steel mills are doing no better. New buying, however, is not on the same relative basis of production, for two reasons. In the first place, there are a good many old orders carried over which are being filled. In the second place, the amount of iron which has been accumulated by consumers was very much larger than had been estimated. Undoubtedly, there was what might be called "a hoarding of iron." Iron was difficult to get during the year. Consumers were urged, as a patriotic duty, to buy ahead, so that their operations would not be hampered for lack of iron. It now turns out that a good many people, fearing a famine, quietly accumulated much iron. All this iron now must be used, and until this stored iron, and until the old orders are worked off, new buying will not represent the actual current consumption of the country.

It is singular that the iron trade should be lagging so far behind, and that there should, on the part of the consumer of iron, be such serious complaint regarding high prices. In other branches of industry, high prices do not act as a deterrent. Cotton stuffs, foodstuffs, stocks on the New York Exchange, all are booming in spite of high prices. Many iron masters believe that we have come to a permanent era of high costs in the manufacture of pig iron, and that high prices in the future will be the rule. These iron masters do not expect that iron can ever be made for less than \$20 per ton, although it costs considerably more than that to make it at the present time.

There is no doubt in our minds that the pig iron trade has been suffering from what might be called "shell shock." We were under a great and tremendous strain during the war, working practically day and night. The very salvation of the country and humanity seemed to depend on the vigor and effectiveness of the iron trade. Then we had a great vision that when peace came the iron trade was destined to suddenly expand and to do greater things than it had done during the war. It looked as though the demands of peace would be immediate and that there would be no stopping. Quite the contrary occurred. The signing of the armistice paralyzed the iron trade, but we are now on the upgrade. It is not much of an upgrade, but the business of each week has been better than the preceding week, and May, so far as compared with January, is 100 per cent better in the way of volume.

TIN SUPPLY.

On May 1, 1919, according to reports made to the American Iron and Steel Institute, the supply of tin (including tin content of tin ores and concentrates) on hand in the United States, in the hands of consumers, jobbers, dealers and smelters, and the unsold portion of the inter-allied tin, was approximately 22,000 tons. Up to May 1, 1919, 6,863 tons of the 10,169 tons of inter-allied tin allocated to the United States had been disposed of. Since May 1, a further 1,107 tons have been sold, leaving a balance unsold on May 23 of 2,199 tons. During January, February, March and April, 1919, the average monthly consumption of tin in the United States, as reported to American Iron and Steel Institute, was 3,713 tons.

ROBERTS COMPANY FORMED.

On April 29, 1919, a charter was granted by the State of Pennsylvania, to the Roberts Company, with offices at 1049 Drexel Building, Philadelphia, for the conduct of a consulting and contracting engineering business. This company will engage itself in covering the rolling mill, steel plant and special machinery fields. A. L. Roberts has been elected president, and V. F. Signorelli, secretary and treasurer of the new company. Mr. Roberts has had nearly 30 years experience with representative firms such as Morgan Engineering Company, Pawling & Harnischfeger Company, Brown Hoisting Machine Company, Brown Cork & Seal Company and the Bethlehem Steel Company, and has specialized during his professional life on machine design, especially heavy machinery for rolling mills and general steel works; cranes of practically every type, hoists, hydraulic machinery, shipyard machinery, steam hammers, coke pushers, etc.

Mr. Roberts' experience includes long association with the best modern practice in pattern shop, foundry and machine shop work, and has demonstrated considerable ability in solving various engineering problems involved in the design of special machinery of many different kinds. He is a member of the American Society of Mechanical Engineers, the Cleveland Engineering Society, and the Association of Iron and Steel Electrical Engineers.

Mr. Signorelli has been identified with the machinery and engineering business for the past five years, during which time he has been associated with the Southwark Foundry & Machine Company of Philadelphia, as secretary and treasurer; the Foundation Company Carpenter-Watkins, Inc., Brunswick, Ga., as auditor, and also secretary of the machinery and machine products division of the War Industries Board, Philadelphia region. Besides being secretary and treasurer of the Roberts Company he is also assistant treasurer of the Malm Engineering Company and auditor of the Eastern Trucking Company, both Philadelphia firms.

INDUSTRIAL RELATIONS

TRAINING IN INDUSTRIAL PLANTS.

Why American industries should profit by a great lesson which the war taught with respect to the value of industrial training, and maintain such training in peace time, is the subject of a bulletin entitled "Training Labor for Peace Time," which has been prepared for free distribution by the United States Training Service, C. T. Clayton, director of the United States Department of Labor, Washington, D. C. This vest-pocket booklet sets forth a number of interesting and significant facts with respect to the present and potential efficiency of labor and the future of industry.

By "industrial training" is meant brief practical instruction for industrial workers in the one best way of doing their respective tasks, such training being given in the plant.

The benefits to employer and employe which such training brings are truly astonishing. Many far-sighted firms already have installed training departments but the majority have not given the subject sufficient attention. The war made training imperative in many instances. The lesson taught in that great emergency should be applied to peace times. We can not continue in the haphazard fashion that obtained before the war.

Today the great majority of workers in America are at tasks, some simple and some complex, for which they have never been systematically trained. It is estimated that 7,000,000 out of the 10,000,000 industrial workers in this country are so handicapped.

A training department such as the training service experts assist manufacturers in establishing is not only designed to start new employes right—important as that is—but it is intended as a permanent feature in the plant for the benefit of all, particularly the poor and mediocre workers. In the long run the systematic upgrading of these workers is the big function of the training department. A worker having recourse to such training in time can greatly broaden his skill and increase his earning power.

Two-thirds of American children quit school on or before reaching the sixth grade and these are entitled to far more facilities for self-development than society now offers them. Training departments are urged as a most practical remedy for this condition.

The factors preventing industrial plants from realizing a maximum output by their workers are classified as follows:

1. Power failure.
2. Failures of equipment and repairs and like limitations.
3. Lack of instructions.
4. Lack of training.
5. Failure to supply material.
6. Personal slacking.

To the last-named item is attributed but 10 per cent of separations. The others, it is pointed out, are within the power of the employer to remedy. The fourth item, lack of training, is one to which much importance is attached. There are over 200 training departments in the United States, it is stated, and they have reduced by one-half the turnover of that part of the working force which they have served. Ninety-three per cent of the departments are reported to be operated without net cost to the employer because the increased production of the learner carries their wages, the cost of instruction, etc.

In the concluding discussion of the pamphlet there is this pointed paragraph. "There is still another consideration that should prompt manufacturers to install systematic training as one of the instrumentalities of their factories. If wage levels are to be maintained while the cost of living is lowered, and if foreign markets are to be opened to American manufacturers, it can only be by raising the national average output. That, in turn, can be accomplished only by increasing the production of the individual through intelligent, widespread industrial training of the workers."

This is but one of several bulletins being issued for free dis-

tribution by the United States Training Service, the address of which is in the Department of Labor, Washington, D. C. Any of them can be had upon request.

FIRING AND QUITTING.

"Not knowing how to do a job has two results: First—low efficiency and, second, quittance or discharge—labor turnover. Each of these operates to increase the cost of production. Both worker and employer pay a penalty for this condition, just as each would profit by its correction."

The above is one of the interesting statements in a vest-pocket bulletin entitled "Labor Turnover and Industrial Training," which has been issued by the United States Training Service of the Department of Labor. The pamphlet contains many other pointed observations of value to manufacturers and labor men, as well as to all others interested in modern economic questions.

In discussing the present enormous turnover in industry the bulletin says:

"It may be convenient to ascribe this excessive and burdensome labor turnover entirely to restlessness, instability, and perversity of the workers. * * * The truth is that labor turnover is not wholly or even largely the fault of the workers."

The publication then goes on to tell of an illuminating study of the causes of discharge and quittances in a large manufacturing plant. But 10 per cent of the separations, it was found, were due to slacking, while 90 per cent were attributable to shortcomings and defects of one kind and another in the management of the plant. The special point which the bulletin makes in this connection is that industrial training conducted in the plant results in the worker being better fitted for his job. Hence he earns better wages, produces more for his employer, has a greater sense of self respect, and remains at his task instead of periodically shifting from job to job.

The United States Training Service is devoting special attention to preparing courses in the proper methods of training in various industries so that interested manufacturers may be supplied with adequate material for operating training departments. In addition to the bulletin mentioned here the training service has issued several other pamphlets on training which will be mailed to anyone addressing the service, care of the Department of Labor, Washington, D. C.

UNIVERSAL ROLLING MILL CO. REORGANIZES.

The name of the Universal Rolling Mill Co. has been changed to the Universal Steel Company, with principal offices at Bridgeville, Pa. The capital stock of the company has been increased from \$300,000 to \$3,000,000; the company being incorporated under the laws of the State of Pennsylvania. The enlarged company has likewise acquired all the assets of the Hussey-Binns Steel Company, with plant located at Charleroi, Pa., and hereafter this plant will be considered the Charleroi plant of the Universal Steel Company. There will be no change in the management of the Universal Steel Company, the former officers of the Universal Rolling Mill Company and the Hussey-Binns Steel Company continuing. The Universal Steel Company's Bridgeville plant is now equipped with:

Three six-ton Heroult electric furnaces; one 30-pot crucible furnace; one five-stand combination plate and strip mill, driven by a reversing motor, and eight stands of 26-inch sheet and jobbing mills, electrically driven.

The Charleroi plant is equipped with:

One six-ton Heroult electric furnace; two 24-pot crucible furnaces, forge equipment with six steam hammers of various sizes; one three-stand 16-inch bar mill; one six-stand 10-inch bar mill; both driven with steam engines.

The product of the company being agricultural plate and sheet steels, tool steel sheets and bars, special and alloy quality strip and bar steel and plates.

NEWS OF THE PLANTS

The Mansfield Sheet & Tin Plate Co., Mansfield, O., is planning for the erection of a number of additions to its plant for increased capacity. The work will include four additional hot mills, four new cold mills, with furnace and general operating equipment. The main building will be 225x400 feet, and will be provided with two 30-ton cranes. With this new installation, the company will have a total of 16 hot mills and 18 cold rolls.

The Midvale Steel & Ordnance Company, Widener Building, Philadelphia, Pa., has under way and has completed a number of improvements at its Cambria works, Johnstown, for increased capacity and improved operating facilities. The work includes a new building for the 48-inch blooming mill; improvements and extensions to the ore bins at No. 1, 2, 3 and 4 blast furnaces; a new ingot stripping plant; the electrification of one of the rolling mill mimes; extensions to the boiler plant at the rod and wire mill; improvements and extensions to the Slick wheel plant; a new reservoir and circulating system at its Franklin coke works, and other improvements and betterments for expansion. The company is reported to be planning for the installation of a new battery of about 60 coke ovens at Rosedale, near Johnstown, and at which point a coke oven plant of this same size was completed late in 1918. The entire works has been designed with the idea of tripling the initial capacity in the future.

The Allentown Steel & Iron Company, Allentown, Pa., recently incorporated with a capital of \$130,000, has inaugurated operations at its new furnace plant at Brick and Furnace streets, Allentown. The initial production will be devoted to cold blast pig iron. It is planned to increase the capacity of the works at an early date, and construction is now under way on a number of other furnaces. The output, as now planned, will be about 10 tons a day. The plant has been designed to produce high grade material for conversion into boiler tubes and selected castings, and for this purpose the material will be of high phosphorus quality. Louis Saab is president.

The blast furnaces of the Wharton Steel Company, Wharton, N. J., have been closed down for an indefinite period owing to the impracticability of producing under present market conditions. Previous to a recent strike at its works, the company had orders on hand for considerable material, and these orders were transferred to other companies owing to the uncertainty of the duration of the strike. The company also operates its own iron mines in this vicinity at Mine Hill, Scrub Oak, etc., and work at these properties has been curtailed.

The Pittsburgh Crucible Steel Company, Midland, Pa., is now operating one blast furnace at its local plant for the production of pig iron. Construction of a new furnace for increased capacity was inaugurated some months ago, and which will have an output of about 60 tons. This new furnace will be augmented by a by-product coke plant to afford coke, gas and tar fuel for company use. This coke plant will consist of two blocks of ovens, each unit having 50 ovens.

The Worcester Pressed Steel Company, Worcester, Mass., is planning for the construction of a new steel mill on property recently acquired in the southern part of the city. The company has secured a site of about 25 acres for the new plant, which will consist of two main structures each about 90x250 feet, with an electric power plant for works operation. The new mill will be devoted to the production of hot rolled strip steel, and will have an annual capacity of about 15,000 tons. The plan will include furnaces, gas producer department, and other works branches to be completely equipped for all features of operation. It is planned to inaugurate construction work some time before the close of the year.

The Trumbull Steel Company, Warren, O., in connection with the acquisition of the Liberty Steel Company and proposed plans for general expansion, is arranging to increase its capital from \$20,000,000 to \$24,000,000. The company plans to develop maximum production at its works, specializing in a large measure for the production of steel for the automobile trade. Jonathan Warner is president.

The Bethlehem Steel Company, Bethlehem, Pa., has been making a number of improvements and extensions to its plant at Steelton, Pa. This work, including construction, which has been completed since the first of the year and now in progress, comprises a 500-ton blast furnace, an extension to the foundry, a new beam and structural shop, extension to splice bar shop, three new electric generator sets, each of 300,000 kilowatts, and gas washing equipment for engine gas fuel. The local plant, it is understood, is now operating at reduced capacity owing to conditions in the market. The company is proceeding with considerable work as planned for the present year at its plant at Sparrows Point, Md. This will include two 500-ton blast furnaces; a large battery of by-product coke ovens, including by-product and benzol plants; eight new gas-driven blowing engines, and four new gas-driven electric generators; four 25-ton converters with mechanical gas producers; 60-inch universal plate mill; 40-inch blooming mill, to be operated in combination with 18-inch and 24-inch continuous mills; a new roll shop, with complete producing and operating equipment; coal crusher and delivery plant, and other improvements.

The Blaw-Knox Company, Pittsburgh, Pa., is planning for considerable increased capacity at its works at Hoboken, Pa. The present main shop building comprises a structure about 80x800 feet, and it is planned to add two new buildings of like size; one of these structures will be used as a forge shop, and the other for general works production. The company specializes in the production of concrete mixers, transmission towers, buckets, steel plate construction, and other work, and the buildings will be equipped to produce specialties of this nature.

The Keystone Iron Works, 973 North Main street, Los Angeles, Cal., manufacturer of well drilling rigs, fire hydrants, pumping machinery, and other iron and steel products, will soon commence the erection of a new plant on Santa Fe avenue, to cost about \$125,000. The initial works will consist of a group of three buildings, about 100x430 feet, 100x380 feet, and 75x100 feet, to be equipped as a foundry, pattern shop, cleaning and core departments, etc. The installation will consist of iron working machinery, foundry equipment, machine tools, power transmission machinery, three electric traveling cranes, electric furnace, two cupolas, and considerable other apparatus. The plant will be fully equipped in all departments of operation.

The Interstate Iron & Steel Company, 104 South Michigan avenue, Chicago, Ill., manufacturer of alloy steels, etc., has commenced the erection of a new one-story brick addition to its plant on South Chicago avenue to be used for increased capacity. The structure is estimated to cost in excess of \$10,000.

ASHLAND FIRE BRICK COMPANY ALLOWED REGISTRATION

The Ashland Fire Brick Company, of Ashland, Ky., have been allowed registration by the United States patent office, of their Savage and Ensign brands of high grade Kentucky fire brick, both of which brands have been used by the company for many years. Registration of the Savage trade mark is covered by registration certificate 125,121, and the Ensign trade mark by certificate 125,122, both dated April 15, 1919.

Lieut. Col. T. S. Hammond has again taken up his former duties as secretary of the Whiting Foundry Equipment Company, having been in active duty with the American expeditionary forces.

V V

Chester K. Brooks, formerly manager of the research department of the National Malleable Castings Company, has been appointed assistant manager of the Cleveland works.

V V

Maj. Alexander Laughlin, Jr., succeeds his father, Alexander Laughlin, as president of the Central Tube Company of Pittsburgh.

V V

Acheson Smith, of the Acheson Graphite Company, Niagara Falls, N. Y., has been elected president of an association called the Electric Furnace Association, whose membership consists of manufacturers and users of electric furnaces.

V V

O. T. Smith is now associated with the Boston office of the Aborn Steel Company. He was formerly connected with the Colonial Steel Company as New England representative.

V V

George P. Pilling, formerly blast furnace superintendent of the Northern Iron Company, Port Henry, N. Y., has been appointed manager of the Philadelphia office of Freyn, Brassert & Co., Engineers, Peoples Gas Building, Chicago.

V V

L. F. Caproni, formerly with the Bethlehem Steel Company, New York office, has recently become connected with the Hay Foundry & Iron Works, as a member of the sales department.

V V

John F. Kent, who has been general manager of the American Cast Iron Pipe, Birmingham, Ala., recently resigned.

V V

William Barry, formerly superintendent of the Monarch Steel Casting Company, Detroit, succeeds F. D. Egan, recently resigned as superintendent of the plant of the Pittsburgh Iron & Steel Foundries Co., at Midland, Pa.

V V

Veryl Preston, who has been president of the Eastern Steel Company, Pottstown, Pa., since 1902, has resigned.

V V

J. E. Fogarty and George Fohl, are, respectively, president and treasurer of the Keystone Foundry Company, Plymouth, Ind.

V V

Max Meltzer is now Philadelphia and New England district manager for the Erie Iron & Steel Co., Erie, Pa. He was formerly connected with the New York office of the E. B. Leaf & Co., Philadelphia, scrap dealers.

Charles H. Elliott is now connected with the Weirton Steel Company, Weirton, W. Va. He recently resigned as assistant superintendent of the blast furnace and steel plant of the Youngstown Sheet & Tube Co.

V V

Marcus L. Filley recently resigned as New York sales manager of the De Forest Sheet & Tin Plate Co., and is now Eastern sales manager of the Mahoning Valley Steel Company, Niles, O.

V V

I. Lamont Hughes has been elected president of the Lorain Steel Company, Johnstown, Pa., a subsidiary of the United States Steel Corporation. Mr. Hughes has been connected with the steel corporation for a number of years, having just occupied the position of general manager of the Ordnance Department.

V V

J. S. Clay has been appointed superintendent of the Connersville Casting Corp., Connersville, Ind. Mr. Clay was formerly superintendent of the American Foundry Company.

V V

Claude S. Anderson has joined the selling organization of the Matthew Addy Company, Philadelphia, Pa., being formerly connected with the Princess Furnace at Glen Wilton, Va.

V V

George H. Niedringhaus has been promoted to the presidency of the National Enameling & Stamping Co., at Granite City, Ill. He was formerly second vice president and manager of the steel department.

V V

Courtney DeKalb recently sailed for Spain for the purpose of investigating the metallurgical and mining resources of that country for the department of commerce.

V V

Robert Hobson was re-elected president of the Steel Company of Canada, Hamilton, Ont., at its recent annual meeting. G. H. Duncan, of Montreal, president of the Dominion Bridge Company, was elected a director to succeed Charles Alexander, of Providence, R. I. Cyrus A. Birge retired from the vice presidency of the steel company, but remains on its executive committee.

V V

Charles Lundgren, formerly general master mechanic of the National Tube Company mills at Lorain, O., has accepted a similar position with the Tennessee Coal, Iron & Railroad Co., Tennessee, Ala.

V V

Charles Lundberg, who for the past two years has been Western editor of *The Iron Age*, having been located in Chicago, has been promoted to the home office in New York as associate editor. Gilbert L. Lacher, formerly of the Chicago editorial staff of the *Railway Age*, will take up Mr. Lundberg's duties at Chicago.

Metal Supply Company, Detroit agents of the Le Moyne Steel Company, Pittsburgh. Mr. Welker was formerly district manager for the Vanadium Alloys Steel Company.

W. V. S. Thorne has been elected director of the Lackawanna Steel Company, filling the vacancy caused by the resignation of E. A. S. Clark.

C. M. Weld has resumed his practice as consulting mining engineer, 2 Rector street, New York, after having been released from his duties as assistant executive of war minerals investigating committee.

F. E. Lucas has been appointed to the newly-created position of economy engineer, of the Dominion Steel Corporation, Sydney, N. S. A. L. Reading becomes superintendent, and W. Buckley assistant superintendent of the rail mill. W. Walshaw has been appointed roll designer. C. C. Graves becomes superintendent of the blooming mill and S. Green superintendent of all the night mills.

John C. Ogden, in deference to the wishes of officials and employes of the Midvale Steel & Ordnance Co., has recalled his resignation as general superintendent of the Cambria Steel Company, of Johnstown, Pa.

John G. Whitham has been appointed assistant district sales manager for New England for the Central Iron & Steel Co., Harrisburg, Pa.

Benjamin G. Lamme, chief engineer Westinghouse Electric & Manufacturing Co., was awarded the Edison medal given by the American Institute of Electrical Engineers, on May 16. More than 150 patents have been granted to Mr. Lamme.

Victor E. Karminski, who recently resigned as secretary and joint general manager of the Rowson-Drew & Clydesdale, Inc., is organizing an exporting company under the name of Victor E. Karminski & Co., Inc., 291 Broadway, New York.

George A. Harder has been elected president and director of the Central Foundry Company, New York, and its subsidiary companies.

George L. Shook is now superintendent of the Port Henry, New York, blast furnace, of the Witherbee, Sherman & Co.

Maj. Kingsley G. Martin, formerly advertising manager of the American Steel Export Company, New York, has been promoted to Lieutenant Colonel in command of base section No. 1, at St. Nazaire, France.

Lackawanna Steel Company, Chicago, is now special representative of the American Chain Company, Inc., Bridgeport, Conn.

Charles T. Fallon has been appointed Boston district manager of the Tacony Steel Company, Oliver Building, Boston.

D. P. Lamoreaux has been elected vice president of the Canadian Car & Foundry Company, Ltd., Canadian Steel Foundries, Ltd., and the Pratt & Letchworth Company, Ltd., with headquarters at Montreal, Quebec. Mr. Lamoreaux, who is in charge of the sales departments of these three corporations was formerly president and general manager of the Beaver Dam Malleable Iron Company.

W. B. Mayo has been made chief engineer of the Ford Motor Company, succeeding C. Harold Wills, recently resigned.

W. F. Rockwell, formerly vice president in charge of engineering and manufacturing of the Torbensen Axle Company has resigned and is now general manager of the E. B. Hayes Machinery Corporation, Oshkosh, Wis.

Duncan G. Sinclair, formerly chief assistant engineer of the Pittsburgh Railways Company and the Duquesne Light Company, is now chief engineer at the New York office of the Pittsburgh Piping & Equipment Co.

L. S. Thompson, formerly with the LaBelle Iron Works, Steubenville, O., is now connected with the structural sales division of the Midvale Steel & Ordnance Co., Philadelphia.

James A. Buell, formerly general superintendent of the United Alloy Steel Corporation, Canton, O., has been promoted to assistant general manager.

Harry F. Coyle is now production superintendent of the Central Steel Company, Massillon, O. He was formerly connected with the Cromwell Steel Company, Lorain, O., and with the Illinois Steel Company, Gary, Ind.

Albert J. Tanck has been appointed Western agent for the National Steel Company, Chicago.

C. R. Dooley, formerly manager of the educational department of the Westinghouse Electric & Manufacturing Co., has resigned to take charge of the vocational work of the Standard Oil Company, New York.

Harry S. Finkenstaedt, having been released from service will represent the Carbon Steel Company as Western sales agent.

Some Pointers on By-Product Coke Oven Operations

NEW BY-PRODUCT PLANT TO BE BUILT.

Capt. George M. Alexander, president of the Monongahela Valley Traction Company, received a communication from C. V. Critchfield, of Toledo, vice president of the Domestic Coke Corporation, stating that he had instructions from the war department at Washington to start at once the construction of the by-product plant at the Fairmont fair grounds. This is the most welcome news that has come to Fairmonters for many months. It is a matter that has been delayed for a time. The plans had been worked out to the satisfaction of all concerned and the contract was let for its construction. The war came and the government saw a splendid opportunity to make explosives and then the plans of the plant were changed so that in its construction the government would be able to get high explosives in large quantities. Construction work was started and was well under way when the armistice was signed and the government's need for these explosives passed. Then it took considerable time for the accounting to be made to determine just what the government was liable. The war department sent several officers to Fairmont and the accounting has been made and everything has been worked out so that the building of the plant may proceed without delay.

For some time there has been some activity at the plant. During the winter there was not much that could be accomplished in the way of actual construction but there has been some work. Koppers Construction Company has the contract for the erection of the 60 ovens that will compose the first installment of batteries of this great by-product industry. Each oven will cost \$50,000, which means that the first unit of ovens will cost \$3,000,000 and to this cost the money expended for rights of way, the construction of buildings, the laying of water lines, the putting in of side tracks and other work to be done, means an expenditure of more than \$3,500,000.

The construction of the plant will now move forward with all possible speed, materials and machinery that are needed in the work will be assembled with all speed possible. There will be no time lost and by spring the fair grounds will present one of the busiest scenes in the entire state. The ovens should be in operation within 14 months.

When the plant is completed and put in operation it will be much the largest coal consuming concern in the entire Monongahela Valley. It will take over 600 tons daily to feed the ovens. This will be converted to coke and into gas the main by-products although there will be a further reduction of the coal for there are a vast number of chemical products that are extracted from the coal. The coke obtained from these ovens is of the highest quality and is sought by the manufacturers of steel.

This is the most important industry that has ever been brought to Fairmont. It is the result of the great awakening that has come to the American people everywhere in the coal industry who have for some time realized that this country has been the most backward of all the nations in the saving and utilization of the by-products to be obtained in distilling coal. The economic effects of the European war forced upon the American people in a manner at once startling and effective the knowledge of this country's dependence upon Europe for commodities that are taken from coal in the process of the by-product oven. All of these commodities can be reduced by these ovens and the industry throughout the United States is growing to be one of the most promising. The long realization of the wastefulness of the old beehive oven process for making coke has long been recognized and the day of the beehive oven is passing. The future holds much of promise for the manufacture of by-product coke.

The gas that is released from the coal is of the best and this can be carried by pipe lines any distance and the quality is not impaired. With the Fairmont field gridironed by gas lines reaching out to all parts of the country, gas can be piped to the points connected. The line already laid is a great boom to this industry which will be enlarged just as fast as it is possible to carry on the construction. For the plant now underway is only one unit of the monster that is to be erected there.

Besides the gas and the coke, tar and oils of various kinds and character are distilled from the coal. These further reduced form other by-products in the way of acids, dyestuffs, explosives and many other things.

The construction and the operation of the plant will give employment to many men. The large quantity of coal consumed will give additional work for miners.

YOUNGSTOWN PRESSED STEEL COMPANY TO BUILD NEW PLANT.

The Youngstown Pressed Steel Company, now operating factories in East Youngstown, Haselton and Sharon, has acquired a tract of land of approximately 40 acres in Warren, at the intersection of the Pennsylvania and Erie tracks, and will build a new plant there at once. It will consolidate, in the new plant, the three factories which they are now operating.

The company was formed shortly after the Sharon Steel Hoop Company bought out the Youngstown Iron & Steel Co., the new company purchasing from the Sharon Steel Hoop Company the pressed steel and fireproofing departments previously operated by the Youngstown Iron & Steel Co., and the channel and corner bead department of the Sharon Steel Hoop Company. The past year and a half have marked a real growth and development of the new organization. The new plant, which will provide ample room for operating the machines now owned by the company, will be nearly four times as large as the combined area of the present factory.

The plant will occupy 291,200 square feet of floor space, and with equipment will cost considerably over \$1,000,000. At the present time the company has arranged with the Warren Building Company to erect houses for the employees which will be sold through the company on easy terms. Between 500 and 600 men will be required to operate the plant to full capacity. The officers state that it is the intention to add new lines of steel products as rapidly as possible and the present buildings have been designed to allow addition in the immediate future of several new products which the company is developing at the present time.

At the present time the products include all types of pressed steel parts for automobiles, trucks, implement tractors and any special requirements where castings and forgings have been previously used. The fireproofing products consist of metal lath, expanded metal, cold formed channels, corner bead, studding, etc.

The erection of the new plant will commence at once and the machinery will be transferred as rapidly as the different buildings are completed.

The space to be vacated at the Haselton works of the Sharon Steel Hoop Company will be utilized in erecting four additional hot mills, which will give the company 15 in all; the warehouse will be moved to the eastern end of the mill yard and a large and modernly equipped machine shop built.

Officers of the Youngstown Pressed Steel Car Company are W. W. Galbreath, president; W. G. Kranz, Cleveland, vice president; A. J. Watson, Youngstown, treasurer. Directors are, besides the officers, Severn P. Ker, George W. Short and J. Reid Evans, Sharon, Pa., and C. A. Manchester, Youngstown.

WITH THE EQUIPMENT MANUFACTURERS

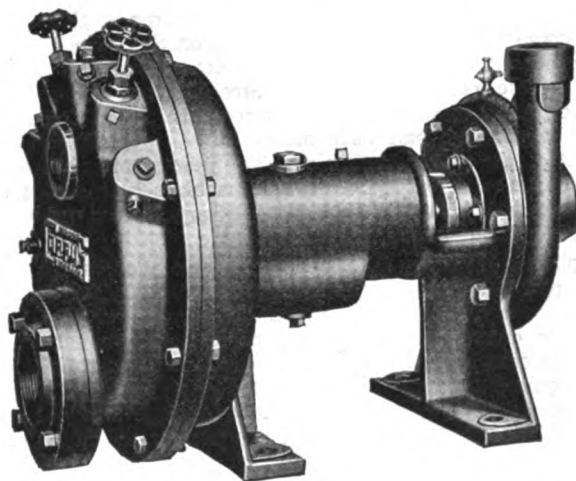
THE NEW ONE UNIT TURBO CENTRIFUGAL BOILER FEED PUMP.

Ever since specially-designed centrifugal boiler feed pumps have demonstrated their efficiency and economy in power plants of modern construction, the owners and operators of smaller power plants have been waiting for a centrifugal boiler feed pump which would meet their requirements.

The only reason that such a pump has not been constructed up to the present time is the fact that practically all pump manufacturers specialize in pumps alone. Since they do not build either steam turbines or electro motors, the driving end of a centrifugal feed pump could not be constructed in the same plant as the pump. This necessitated the two unit type of construction, involving a more expensive product than most small power plants are willing to invest in.

A manufacturer of small power turbines, the Coppus Engineering & Equipment Co. has just placed on the market a new steam turbine driven centrifugal boiler feed pump especially designed for boiler feeding in plants of 100 to 3,500 Bhp. Every care has been taken to see that all the advantages of centrifugal feed pumps which have proved so successful in larger plants, have been retained in this smaller, more compact unit.

Both the pump and steam turbine are combined in a single unit—and thus the pump occupies but very little floor space.



Simply designed, compactly constructed of the best materials, in a plant newly equipped for the purpose, the new pump promises to come into general favor in a very short time.

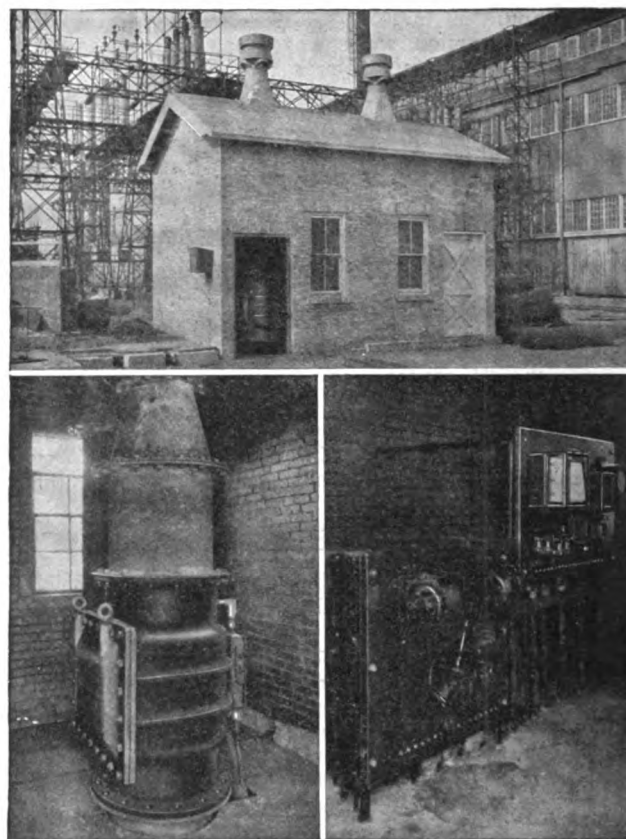
As with larger centrifugal boiler feed pumps, the exhaust steam is free from oil, there is no water hammer so injurious to pipe lines and valves, and the steam consumption is unusually low. The feed water capacity is controlled by regulating the hand valves at the boilers, a saving of time that will be much appreciated by any power plant engineer.

RECORD INSTALLATION OF THOMAS METER.

The Thomas meter which measures gas electrically and shows the results in standard units, on a graphic chart has been previously described in the columns of **BLAST FURNACE AND STEEL PLANT** and from time to time interesting installations have also been illustrated and mentioned. A time record delivery and installation was recently made at the new plate mill of the Brier Hill Steel Company, Youngstown, O. On Friday, January 10, a request was made of

the Cutler-Hammer Manufacturing Company, at Milwaukee, Wis., for a 600,000 cubic feet per hour Thomas meter to measure the total supply of coke oven gas to six furnaces in the new plate mill. Fortunately the Cutler-Hammer Company had the parts of a meter of about that capacity in such shape that by working all Friday night, the meter was ready Saturday, January 11, for shipment.

It is desirable and often necessary to measure a commodity as purchased by one company from another company, or by one department from another department, and when the rate of consumption can be shown graphically such records not only give valuable data for account purposes but



The upper photograph shows the meter building with the new plate mill in background. The lower photographs show the Thomas meter housing on the left and to the extreme right, the instrument panel which records the flow of gas in standard units without any corrections in temperature, pressure, barometer, etc.

also form the very basis of efficient production. The early installation was required and the work on the building and piping carried along with dispatch so that six days after the order was placed, the meter was measuring gas to the mill.

The accompanying illustrations show the meter building, the meter housing, the regulating panel and the recording panel. From these may be gained some conception of the large amount of work that was done between Sunday and early Thursday morning.

The Thomas meter records the measurement of gas in standard cubic feet and is not effected by change in tem-

WITH THE EQUIPMENT MANUFACTURERS

perature, pressure, composition, or barometer, making it particularly well suited for efficient checking of gas consumed in various steel mill processes.

THE LEA SIMPLEX SAW.

In many steel plants there is usually a percentage of product which is to be shipped to the customer rough finished.

It may be that but a crop end of a forged bar must be cut off, or again, an odd shape needs to have one face finished, or a long bar cut into lengths for the customer accurately and squarely.

The most useful and economical tool for any of the above mentioned operations is a cold metal saw, but in the selection of such a machine, there are several points which must be given careful consideration.

First—Simplicity of construction and operation that a cheap operator can be employed.

Second—Compactness so as not to encroach on valuable floor space.

Third—Rapidity and accuracy of cut, and a very important consideration is to select a type having an accessible table top and rapid clamping device.

The Lea simplex cold metal saw, manufactured and sold by the Earle Gear and Machine Company, Philadelphia, Pa., has the advantage of 15 years successful operation.

This machine early found favor with production managers and participated in the remarkable development of the past 10 years of high production plants, such as in the automobile industry. The list of installations covers nearly every one of the prominent plants where production is paramount and many of them have batteries of these useful machines.

A sprocket-driven saw, to which type the Lea simplex belongs, has a larger capacity for a given diameter of blade than any other style of machine, and the blades can be changed when necessary in a few moments. All the levers controlling the operation are concentrated at one point, and the feed can be regulated (five different quick change gear feeds) while the cut is in progress. Thus the cut can be retarded when passing through a heavy section and speeded up for light sections. A safety clutch is provided to protect the blade if too heavy a feed is selected by the operator, also an automatic trip to stop the cut at any predetermined point.

Each machine is a compact self contained unit, whether motor or belt driven. In motor driven machines the motor is mounted directly on the machine; geared in. If belt driven, no countershaft is required, which is an important item.

CIRCUIT BREAKER.

The Automatic Reclosing Circuit Breaker Company has recently placed on the market a new circuit breaker of 3,000 and 4,000 ampere capacity. This breaker is an electro-magnetically operated circuit breaker, having the following characteristics:

(a) Breaker is closed and held closed by means of an electromagnet.

(b) Opens automatically in case of overload, short-circuit, or voltage failure.

(c) Remains open a definite time interval regardless of cause of opening.

(d) In case breaker is opened by a short-circuit, the breaker makes no attempt to reclose while the short-circuit exists, but closes instantly upon the removal of short-circuit or overload.

The main contact brush is of a laminated butt contact type. The studs are of laminated construction, the lower stud being slotted vertically and the upper stud being

slotted horizontally. The main contact brush is protected from arcing by an auxiliary copper contact shunt and the final arc is formed on upper graphalloy contact tips. The upper arcing tip is supported on a pivoted support actuated by a strong compression spring so that the upper rear tip follows out at a considerable distance in opening, thereby insuring good contact of the arcing tips until brush and auxiliary contact are separated from their respective contacts. The upper rear arcing tip is also pivoted directly on a bracket so that it is free to align itself with the front contact in all positions.

Provision is made for adjusting the tension of the main brush by means of an eccentric bushing in the brush support.

This breaker is of very rugged construction and is particularly adapted to heavy duty work such as is met with in steel mills and street railway service.

PORTABLE ELECTRIC DRILL.

A portable electric drilling machine has recently been advantageously employed in countersinking ship plates at a number of fabricating shops engaged in work for the Emergency Fleet Corporation. A wall radial drill has usually been used for this purpose, but the portable electric drilling machine attached to a buggy designed for the purpose has resulted in greater speed and a reduction of labor cost.

The buggy was supplied by the Louis F. Shoemaker Company, Pottstown, Pa. This company has supplied a similar buggy to the Hog Island Yard of the American International Shipbuilding Corporation. Buggies similar in design, have been built by other fabricating shops.

For use with this buggy the Van Dorn Electric Tool Company, of Cleveland, has recently designed a portable drilling machine, very powerful and of heavy, rigid construction. The machine is fastened into the buggy by two studs, these studs being screwed to trunnion bosses on the housing and fastened to the handles of the buggy. The buggy is counterweighted in front, leverage being provided by pressure applied to the handles. The plates being laid out on the shop floor it requires only an instant to move the machine from one hole to another.

The Van Dorn portable electric machine is ball bearing throughout. The top head and gear housing are bolted to the motor housing, eliminating tapped holes and worn out threads. A double row of ball bearings withstand both thrust and radial load.

This particular machine is for use with direct current but the Van Dorn people will also furnish machines for alternating current. It consumes 230 volts. Its maximum speed is 425 rpm and 160 rpm under full load. Its spindle output at 20 amp. is 4½ hp.

The machine measures 22 inches over all in length and weighs 125 pounds. It is equipped with No. 4 Morse taper socket and will countersink a hole up to one inch in diameter. It is claimed that the buggy enables this machine to countersink a ¾-inch hole in seven seconds.

H. L. Garbutt, for the last six years manager of the line material section of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, has been appointed manager of the supply division of the Westinghouse San Francisco office.

In 1908 Mr. Garbutt became a part of the sales organization of the Drew Electric & Manufacturing Co., of Indianapolis, handling various types of overhead line material, with which company he remained until 1909, when he entered the supply department of the Chicago office of the Westinghouse company, as line material specialist, in which position he served until 1913, when he was made manager of the line material section, with offices at East Pittsburgh.

Trade Notes

E. T. Causer has recently resigned as works manager of the R. D. Nuttall Company, Pittsburgh, Pa.

A pyrometer sales and service department in charge of Henry Brewer, has been opened at 1304 Monadnock Block, Chicago, by the Leeds & Northrup Co., of Philadelphia, manufacturers of the potentiometer system of pyrometry and other electrical temperature measuring instruments. Service to pyrometer users and to prospective users will be rendered from this office. A complete standardization equipment will be maintained. Certification of thermocouples and of pyrometer equipments will be furnished in terms of standards certified by the United States Bureau of Standards. Particular attention will be given to maintaining equipment after installation.

Morgan Construction Company has been awarded the contract for a 12-inch merchant bar mill by Societe Anonyme de Firminy of France. The mill is to be placed in a new works of the French company, known as Usines des Dunes, which is being erected near Dunkerque. This bar mill will be similar to one built a few years ago by the Morgan company for Youngstown Sheet & Tube Co., and will be designed to produce round sections from $\frac{1}{4}$ to $2\frac{1}{2}$ -inch diameter and flat sections from 1 to 6 inches wide. Equivalent weights of angles, beams, squares and other ordinary sections can also be rolled. A large part of the construction work will be performed in France and only a comparatively small amount of special machinery for this order will be built in Worcester.

J. W. Spensley, who has had several years experience as crane sales engineer, will represent the Champion Engineering Company of Kenton, O., manufacturers of Champion cranes, in the New York territory, beginning June 1. Mr. Spensley has opened a sales and service office in New York, at 149 Broadway, Room 1001, Singer Building.

Frey, Brassert & Co., Engineers, Chicago, and employees, have purchased bonds in the amount of \$30,000 of the Fifth Victory Loan.

Due to the increasing demand for their products, sil-o-eel brick, powder and cement for insulation and filter-cel for filtration, in the Detroit district, the Celite Products Company has appointed Ward D. Dygert, Book Building, Detroit, Mich., as their representative. Mr. Dygert is well known in this district and possesses engineering knowledge and sales experience that will enable him to creditably handle their business. Warehouse stock will be carried to insure prompt delivery.

The Walter A. Zelnicker Supply Company in St. Louis, has just appointed F. X. Meehan as their advertising manager.

An arrangement of considerable interest and importance to the build-

ing contractor, engineer and architect, has just been consummated. The Blaw-Knox Company has taken over the manufacture and field operation of the Uni-Form System of reinforced concrete floor and roof construction, and the Uni-Form System is not incorporated in the steel forms department of the Blaw-Knox Company and will be known as Blawforms.

Beginning on the 15th of this month the Champion Engineering Company has appointed the Williams & Thomas Machinery Co., Inc., with offices at 820 Commercial Trust Building, Philadelphia, exclusive agents for Champion cranes in that territory. R. F. Williams, president of that company, who has had extensive experience in crane sales engineering work for a number of years, will be in direct charge of affairs in that territory.

Trade Publications

The Metal & Thermit Corporation, New York, N. Y., has issued a folder entitled "How Thermit Healed My Broken Jaw," which illustrates the operations involved in making a thermit weld on the 13 $\frac{1}{2}$ -ton broken upper jaw of an alligator shear used by Jos. Joseph & Bros. Co., Modena, Pa. The break welded was 80 inches in length and varied from $\frac{1}{2}$ to 23 inches in thickness.

Sockets to Harmonize, is the title of a new 4-page two-color 3 $\frac{1}{2}$ x6 inch envelope stuffer which emphasizes the harmony to be secured through the use of C-H push button porcelain sockets with white enamel fixtures. They also eliminate the frequent and annoying accidents due to touching brass shell sockets when operating the faucet or other metal parts in bathrooms, laundries, hospitals, kitchens, and other places where moisture may be present. The new folder lists the pendant and fixture types of push button porcelain sockets as manufactured by the Cutler-Hammer Manufacturing Company of Milwaukee, and is intended for distribution by jobbers and dealers when imprinted for them.

"Melting Metal With Electrically Heated Pots," is the title of a new 6-page 3 $\frac{1}{2}$ x6-inch envelope folder which has just been published by the Cutler Hammer Manufacturing Company, of Milwaukee and New York. This folder calls attention to the advantages of electrically heated melting pots over gas and gasoline, on account of cleanliness, elimination of open flame, greater efficiency and ease of control. C-H electrically heated metal melting pots are made to melt down and maintain at the proper temperature, all soft materials, such as lead, tin, solder, babbitt, etc. They are limited to a maximum temperature of 550 degrees F., and are made in standard sizes up to 150 pounds metal capacity. Two types are described in this new folder, the floor type being made in 10 and 25 pound sizes and the bench type in 50, 100 and 150 pounds capacity. Automatic temperature control equipment

similar to that used on electric linotype pots is furnished at the option of the purchaser with either of these two types. The automatic temperature control consists of a dynamic thermometer and the control panel. The bulb of the thermometer is immersed in the metal and the coil is set to the temperature desired. The action of the equipment is such that the metal is kept between a minimum, and a maximum temperature, the current being turned on only when the temperature of the metal drops to the minimum. Prices, dimensions, and other descriptive matter are included.

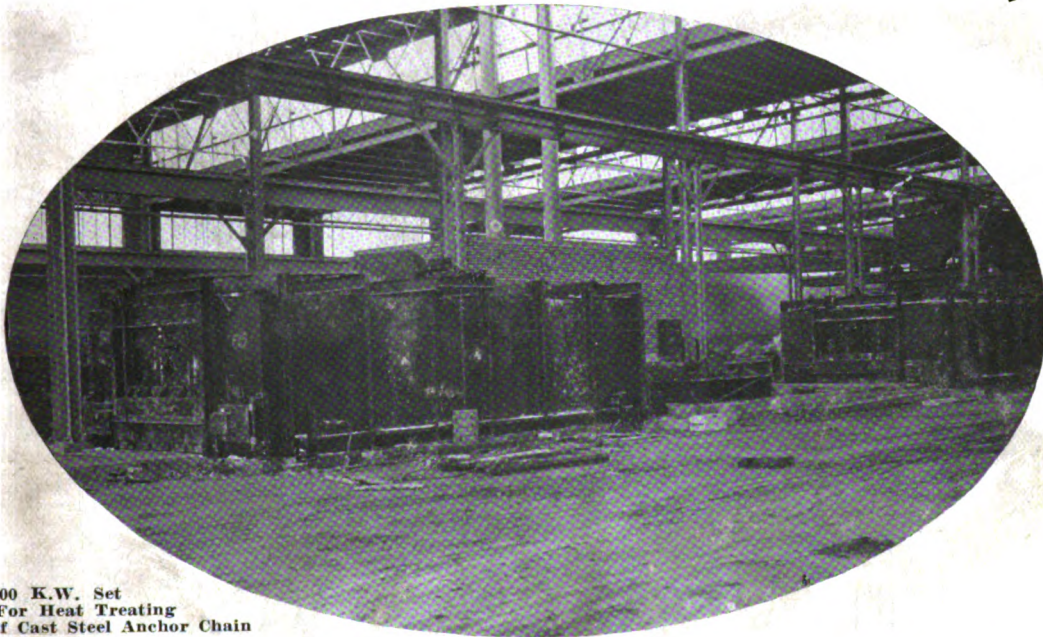
"Kinite, a Patented Alloy Steel" is the title of a new 4-page 8 $\frac{1}{2}$ x11 inch descriptive folder being distributed by the Kinite Company of Milwaukee. The BLAST FURNACE AND STEEL PLANT recently devoted its columns to a description of this new steel, which is especially adapted for making cutters, dies, taps and other tools with multiple cutting edges. Unlike other tool steels, kinite is cast and not forged. It has the appearance, however, of a good smooth forging and also has a peculiar property in that it does not elongate under tensile strain nor decrease in cross-sectional area. Castings made from it do not change shape nor form in the hardening process, hence, it is possible to make a casting so near the desired shape and size of the finished tool that very little machining of labor is necessary to complete it. This characteristic of not shrinking makes it a valuable metal for moulds for casting hot substances such as glass and for moulds for casting hot substances such as glass and metals that melt at or below 1,600 degrees F. These substances usually contract on cooling and do not adhere to the kinite mould, since it does not change shape or dimensions with changes in temperature. The booklet calls attention to the other properties of this new tool steel and contains illustrations of several large dies, one of them being a multiple die, which while working at a temperature of 550 degrees F., has punched and formed about 4,000,000 pieces. To have made this die from ordinary tool steel, many parts would have to be lapped and ground together, whereas with kinite, the complete die was cast in a single piece.

Reducing Ash Disposal Costs—The American Steam Conveyor Corporation, Chicago, has just issued another helpful booklet on the ash handling question. Of special interest to engineers and power plant executives will be the diagram and description of an American steam ash conveyor, that saved over \$3 a day in ash handling and in the course of 18 months, paid for itself. The experience of a number of other users of the steam jet ash conveyor in securing ash disposal economies are described. Diagrams and photographs of actual installations are used to liven the booklet, and give it a touch of human interest. A copy of this booklet will be sent free to all who are interested in the subject of ash handling economies.

The Blast Furnace *and* Steel Plant

Pittsburgh, June, 1919.

Baily Electric Furnaces



900 K.W. Set
For Heat Treating
of Cast Steel Anchor Chain

Heat Treating Controlled

Electric Furnaces solve the heat-treatment problem by applying the perfect control of electricity to the complete cycle of heat treatment: Hardening, quenching, drawing, and to annealing as well. Each **Baily Electric Furnace** is of the **Resistance Type**, in which heat is generated by the passage of electric current through rectangular resistor troughs filled with broken carbon. Heat is radiated from these incandescent filaments to the roof, and from there is evenly reflected upon all the material under treatment on the hearth. This makes the most simple and rugged type of electric furnace in existence.

Every **Baily Electric Furnace** is a complete unit with transformers, selective oil-break switches, and complete equipment, all built by **The Electric Furnace Company** in its own factory. **Baily Electric Furnaces** are built in the following electrical capacities: Hearth Type:—40 K. W. for heat-treating gears.

Pusher Type:—150, 360, 600, and 1,500 K. W. for heat-treating steel, copper, brass and aluminum.

Car Type:—150, 300, and 600 K. W. for annealing steel and steel products.

Automatic Type:—250, 900 K. W. continuous furnaces for heat-treating castings and forgings in quantity.

Write today for our Catalog.

THE ELECTRIC FURNACE COMPANY

General Offices: Alliance, Ohio.